The Welding Engineer

VOLUME XXII FEBRUARY, 1937 NUMBER 2

Welding Aids in Emergency Work in Ohio River Flood . . .

WHEN unprecedented rains in the Ohio River valley recently resulted in the most disastrous flood in the history of that section, welding supply houses and job welding shops suffered along with other industries in the path of the high water.

The Queen City Supply Co., large distributors of welding equipment and supplies in the Cincinnati territory, continued to supply emergency materials even when the water had risen almost up to the second floor of their establishment. Finally another firm, more favorably located, offered them warm, dry headquarters, and contact with the world was re-established. After the water subsided, they moved back to the "old stand." By moving their stock early, they saved much of what was on their first floor and their cellars. A folder issued to their customers after the flood, showing their building with the first floor almost entirely submerged, though the crest of the flood was still four feet higher, announced that they are now able to give service on telephone call and that their trucks are operating.

Engaged in Cleaning Up Plants to Resume Operations

Paul G. Lucas, of the company's welding division, says that several of Cincinnati's job welding shops and large industrial users of welding were affected by the flood, and, like themselves, are now in the midst of straightening out their plants so as to be able to resume operations.

The hardest hit of all the cities along the Ohio River was Louisville, Ky. About three-fourths of the city was inundated, and industrial buildings and residences suffered alike from the muddy flood waters. Most of the city's industrial plants had from 2 to 8 ft. of water in them, submerging the plant equipment, including welding equipment. Quite a number of gas-driven welders were pressed into service for temporary lighting purposes, and oxyacetylene equipment was used extensively in cutting and in the welding repair of buildings, machinery, etc., says Vincent W. Adams, of the Neill-LaVielle Supply Co. of Louisville.

Welding Used to Make Boats and to Render Steel Doors Watertight

One large plant which does quite a bit of welding turned their entire facilities over to making steel boats, one boat being turned out each hour, says Mr. Adams, and another company used their electric welders to weld up the steel doors around the power plant so that water would not seep through cracks and put the wiring out of commission. Two very severe explosions and fires in Louisville were caused by leaky gas mains.

The plant of Tube-Turns, Inc., in Louisville, manufacturers of pipe welding fittings, many of whose employees had their homes swept away in the flood, put their men back to work as speedily as the falling flood waters would allow and offered aid to their employees' families. Two diesel-electric generating sets were rushed to the plant from the Caterpillar Tractor Co., in Peoria, Ill., so that operations might be begun several days in advance of the resumption of electric power service to the city.

Another Louisville firm, the Henry Vogt Machine Co., large users of welding, supplied power to two hospitals and two baking companies, and also furnished part of the requirements to the city hall and the American Telephone Co. The company willingly shut down its own assembly plant so that it might furnish power for these emergency purposes.

The flood took a heavy toll at Paducah, Ky., almost completely covering the city. Here is located the shops of the Illinois Central Railroad, where a vast amount of welding and cutting is employed.

Another city that suffered severely from the flood was Evansville, Ind., in which is located several large industries employing a great amount of welding. Here, as in many of the other hundreds of communities in the path of the flood, the homeless were taken to refugee camps or to communities more fortunately situated, the sick were cared for in improvised hospitals, and all avenues of transportation were kept open wherever possible to permit the receiving of emergency rations, drinking water, medicine and other necessities.

Emergency Pipe Work Finds Uses for Welding

In some of this work, welding played an important part. Many welding repairs were made to pumping equipment and generators, the value of which is beyond estimation. Pipes feeding water to cities, as well as power-station equipment, were in many instances kept in service by employing welding, reports Ivan H. Holder, of the Evansville Supply Co., of Evansville.

Mr. Holder cites one instance where a waterworks supplying a fair-sized city became inundated and all pumping had to be stopped. A tight barricade was immediately laid around the vital part of the plant, and large pumps were mounted on barges and floated alongside. By means of welding and cutting, suction and discharge pipelines were quickly fabricated, and the water was pumped out of the plant, allowing it to resume operation.

Oxyacetylene Welding in the Operation and Maintenance of Pipelines

Paper read at the convention of the International Acetylene Association, St. Louis, November 18-20, 1936.

By R. P. GONZALES
Asst. Superintendent, Pipeline Division, Arkansas Louisiana Gas Company

IN THE pipeline business, we use the term "good pipeline practice" to cover those methods of operation and maintenance which by successful experience have come into general use. Oxyacetylene welding is now universally accepted as a necessary part of the operation and maintenance of pipelines, but because of the limitation of successful experience, the applications of welding to good pipeline practice will always be behind the latest developments.

Natural-gas pipelines are usually the major sources of fuel for the communities and industries which they serve. Interruption of operation for even a brief period would result in discomfort to domestic consumers and in confusion to industries connected. The sale of natural gas is by meter at the time of consumption. Sales lost through interruption of service are forever lost. A failure of any part of a natural-gas system may completely paralyze the whole system, with considerable financial loss to the operating company and to the industrial consumers, in addition to the loss of goodwill of customers. Any major natural-gas system represents a large investment, and the loss in revenue alone through interruption of service may amount to as much as $20 per minute.

Fear of Disrupting Service Has Deterred Adoption of New Ideas

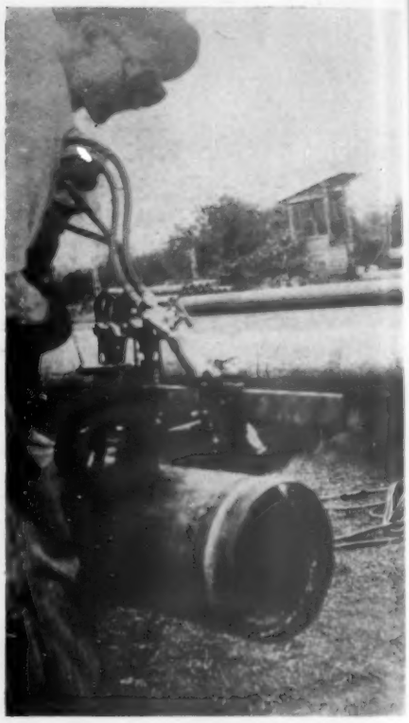
Because of the fear that new methods and ideas on operation and maintenance might jeopardize the service, those responsible for the operation of natural-gas pipelines are inclined to stay with the older and fully tried methods.

The operation of a natural-gas pipeline system is usually in four divisons: gathering lines, compressor stations, main lines and distribution or low-pressure lines. The gathering lines and main lines may be maintained by the same personnel, but operation of compressor stations and distribution lines is usually separate because of the requirement of specially trained operators.

Welding Used in Compressor Stations for Many Years

Oxyacetylene welding was used for a number of years in the construction and operation of compressor stations before it came into general use for pipelines. The first uses were in the fabrication of cooling coils and manifolds. Welders employed on the construction of the stations often became a part of the permanent operating personnel, and the fact that they were available brought about added uses of welding in compressor-station operation and maintenance. A complete welding and cutting outfit is provided in the repair shop of all large compressor stations. The uses of welding at a compressor station are similar to those at any power plant, and the consumption of welding materials is comparable to a general repair shop in a small community.

The operation of gathering lines and main lines in a natural-gas system is divided into districts, the extent of each district being governed by the ability of a maintenance crew to reach any part of the district quickly in time of trouble. Gathering-line crews often maintain a part of the main line extending from the field where the crew is stationed. The operation of gathering lines includes a good deal of small pipeline construction. It is necessary to add connections to new gas wells continually in order to replace the potential gas supply being lost in depleted wells. The operations of a gathering-line crew, therefore, not only involve maintenance but also salvage of old lines and construction of new lines, and the organization of this crew must be on the order of a small construction organization and include a qualified welder for laying out, connecting and fabricating drips, separators and special fittings.



Beveling a Pipe End for Welding.

Reconditioning and Relaying of Pipelines Requires the Use of Welding Equipment.

Truck With Tools and Torches Kept Ready for Emergencies

The first duty of the main-line maintenance crew is to keep the line in continuous operation, particularly during the winter months. They must be prepared for an emergency at any time during the day or night. A complete oxyacetylene welding and cutting outfit is

Making Rolling Welds in the Field.

Streams Do Not Impede the Progress of the Pipeline Gang.

one of their standard tools and, together with other repair tools, is usually kept loaded on a truck during winter ready to go at a minute's notice.

The personnel of a main-line maintenance crew usually includes one or more qualified welders. It is preferable that the foreman be qualified to handle oxyacetylene welding and cutting equipment in the case of emergency.

Maintenance Crews Kept Busy on Odd Jobs in Idle Moments

During periods of extremely cold weather and peak delivery on a natural-gas system, it is customary to hold the maintenance crews at their stations so they may be reached quickly and directed to any point of trouble. Work is provided for them at these stations, while they would otherwise be idle, by employing them in the cleaning and reconditioning of salvaged pipe and fittings. Since the welder in the crew would be otherwise unemployed, it is found profitable to cut out short usable sections of damaged pipe and weld these sections into joints of standard length. By employing a pipe-beveling machine and an economical welding method, it is often found profitable to a pipeline company to salvage and return to usefulness by welding into standard lengths short pieces of pipe (commonly called pup joints) no longer than 30 in.

In the repair of main-line breaks, the use of oxyacetylene welding and cutting equipment is often very valuable in the removal of damaged sections and replacement with serviceable pipe. Each repair job presents a new problem. Hence, a repair-gang foreman, thoroughly acquainted with the advantages of the use of oxyacetylene cutting and welding equipment, is preferable as a leader of a repair crew.

A leak in a gas line usually increases rapidly in size as a result of abrasion by small particles in the gas stream. When leaks are discovered, they are given temporary repair as promptly as possible. On small leaks, saddles will often serve, and on larger leaks split sleeves are used. The purpose of the temporary repairs is to keep the lines in continuous working condition during the winter months or during periods of high delivery.

Permanent repairs are postponed until sections of the line can be temporarily removed from service without interference with satisfactory service or inconvenience to customers. Periods of low delivery, when permanent repairs may be made, usually occur on Sunday afternoons in the summer time, and therefore all permanent repairs are scheduled for summer periods.

Corrosion is usually most active on pipelines in short sections which are known as "hot spots." These hot spots usually vary from a few feet to a mile or more in length. When a number of leaks are given temporary repair in a short section, this section is scheduled for replacement during the summer months. Because of the fire hazard involved in replacement or reconditioning of natural-gas lines, it is necessary to take the section temporarily out of service. Main-line gate valves are located at convenient intervals along natural-gas lines to permit isolation of sections for repair and replacement work. By packing or increasing the pressure of gas in the line, a gas storage can be built up which will permit shut down of the line during a period of low delivery without loss of service to customers.

Pipe Replacements Made With Shut-Down of Only Few Hours

On a replacement job, the bad section is uncovered in readiness for removal. A section of pipe to be used in replacement is welded up at the side of the open ditch. When all is in readiness, the main-line section where the replacement is to be made is isolated by closing the main-line valves at each end. The section is then drained and is cut at each end and raised out of the ditch, after which the new section is lowered into the place of the old pipe and is connected by welding. If the job is properly planned, the length of the section to be replaced has no influence on the time required for the job, as the only work to be done is at each end of the replaced section. A replacement job can be done with a shut-down of only a few hours. The pipe removed from the replaced sections is hauled to storage points, where it is reconditioned for further use.

Often a 20- or 40-ft. length of pipe is rendered unserviceable by corrosion or electrolysis in the line. When the extent of damage to the pipe is less than one-tenth the length of the joint, the pipe can be recovered for further usefulness by cutting out the damaged part with a pipe-beveling machine. Then, by welding up the useful parts thus recovered, it is made into a serviceable joint. Pipe removed from screw lines or coupled lines can be prepared for use in welded lines by beveling the ends with a pipe-beveling machine. In most cases, better than three-fourths of the pipe removed from badly corroded sections can be reconditioned by welding the corroded pits, cutting out completely damaged parts, and welding into standard lengths.

In the organization of pipeline repair crews, each member must be fitted for several jobs. It is not unusual for a welder to serve also as tractor driver or truck driver. On salvage work, pipe-beveling-machine operators are usually selected from the men who have become familiar with the preparation of pipe ends for welding.

Using a pipe-beveling machine, regular permanent employees of maintenance crews average 10 cuts per hour on 16-in. pipe on the reconditioning rack, and have made as many as 20 cuts per hour for extended periods on preparation of salvaged 10-in. screw pipe for use in welded lines.

With the use of oxyacetylene welding and cutting, a maintenance and repair crew can be converted from a burden of expense to a profitable organization by using their idle time between repair jobs for the salvaging and reconditioning of used pipe.

Oxyacetylene welding and cutting are indispensable in the operation and maintenance of pipelines. In the equipment of the pipeline crew, the oxyacetylene outfit is equally as necessary as a long handled round-point shovel or a pipe wrench.

Double Crank Press During Process of Assembly

(The use of bent plate adds beauty to the appearance of the uprights.)

Welded Steel *in* Heavy Machinery. . .

Paper read before the Milwaukee Section, American Welding Society, at Milwaukee, Wis., Jan. 21.

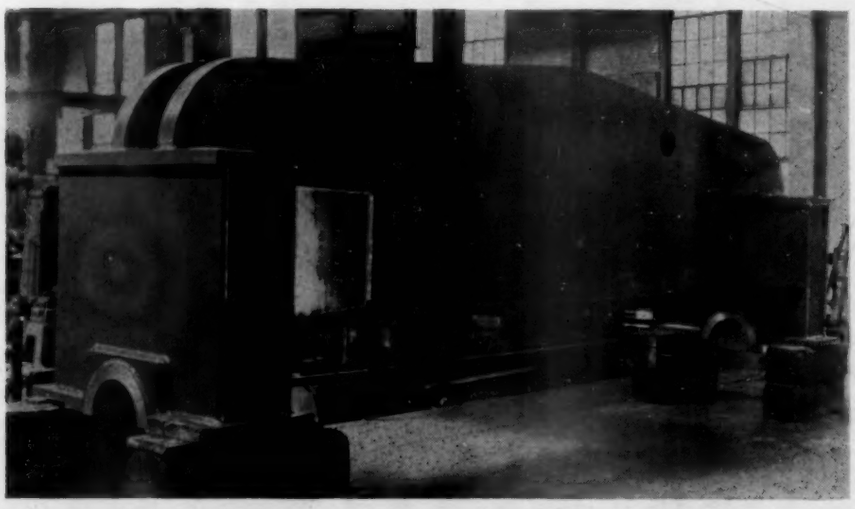
By HAROLD VERSON

Chief Engineer, The Allsteel Press Co.

THE application of arc welding to the manufacture of heavy machinery is so natural a process that, like all other simple transitions, it is apt to run away from us. This particular field offers so many possibilities, and can be approached from so many angles, that particular attention must be paid to every phase of design and construction. The problem is not merely one of designing a structure to perform a certain job, but also of designing that structure so that it can be constructed in the most economical way.

We have witnessed a mad scramble to weld everything, but by this time we all have sufficiently cooled off to really attack each individual problem, not only as to the best way to design it as a welded structure, but to consider whether an entirely welded structure *is* the best design. We have finally come to the refinement processes which will not only improve our welded products but which take into account several important factors that we have overlooked or ignored. It is no longer a question of whether to weld or cast, but whether, by designing in a certain way or by combining the two, will we get a more rigid and better appearing product at a lower cost.

The designer should, and can, decide very early in the design, the definite line of procedure. A practical knowledge of the materials with which we are working, plus a general idea of cost, is all that is necessary. However, to set down a definite line of procedure, especially in heavy machine-tool welding, would be foolish, because each individual shape and structure presents its own problems, and must be handled in such a way as to compensate for this individuality. The size, shape and quantity, all have a direct bearing on cost, and each must receive consideration. However, aside from numerous minor details that are usually ironed out in everyday procedure, there are certain fundamental principles that can be followed and which have a direct bearing on profit and loss.



Crown Weighing 30 Tons, Completely Fabricated and Constructed in Two-Weeks Time.

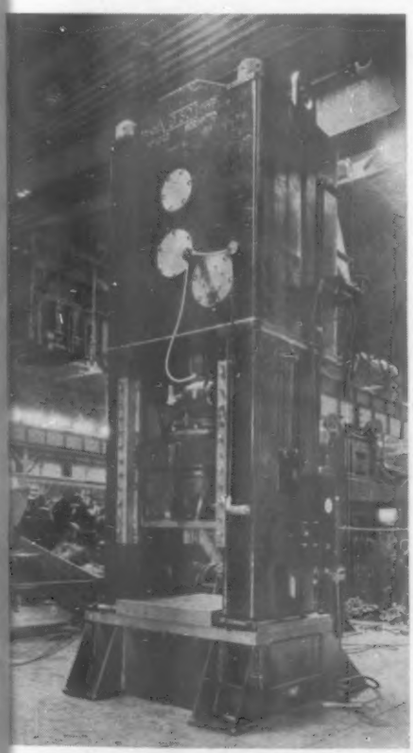
Shop Facilities Must Be Taken Into Account in Design

To begin with, a primary factor in heavy welding is the limited handling facilities in the average shop. Not many shops in the entire country can boast that they need not consider this an important factor in determining design. By handling facilities, I mean not only lifting capacity but, more important, the machining possibilities. If a given welded member is to be built completely in a shop of limited capacities, both in handling and machining, then it should be so designed that a minimum of time

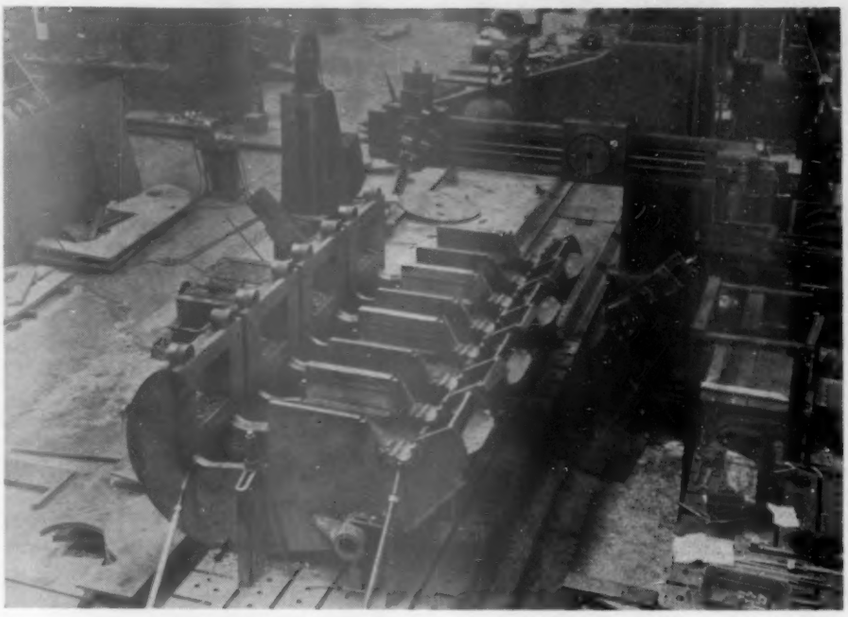
will be lost in either department. The shop should not be forced to face a periodic headache trying to handle and machine a welded structure that is entirely lacking in proper machining possibilities.

A given member can be designed in two different ways and effect at least a 50% saving in one of them in handling, welding and machining time. The completed structure first would be considered as composed of several units, each to be treated as an individual structure. In this way, not only is the design as a whole bettered, since more attention is paid to detail, but costs are directly reduced in almost every department along the line. First, it is possible to use smaller pieces of steel, and hence provide an outlet for steel which would otherwise be unusable. A small member is far easier to line up individually and can in all probability be welded without the necessity of using a crane for positioning. This procedure reduces handling to the minimum, since if all welding was left to be done until the entire structure was tacked together, it might be necessary to position it in sixteen different ways in order to weld it properly, which would be a dangerous and costly procedure—dangerous, because of its great size, and costly because at least two men and a crane would be required to do what one man and a jib crane could probably do.

More often than not, each individual member can be rough machined wherever necessary, before it is tacked to the other members, thereby saving at least one roughing cut on a larger, more expensive machine tool. Then again, there may be numerous holes or cutouts that can be provided in the sections, and so save expensive setups later on. Another factor to consider, and in reality one of the most important in welding, is that a structure composed of several rigid individual members is less liable to warp in the final process. All that may be necessary is to provide small triangles and support plates at necessary points to keep overhanging plates from pulling over.



Completed Eccentric Press
(The sectional construction makes for easier handling. Bent plate is used, adding to the trim appearance of the machine.)



Housings of Four Open-Back Inclinable Presses.
(These are equipped with steel-casting bearing inserts. There are obvious advantages to running several housings through the shop at the same time.)

Heavy Plate and Light Plate Each Has Advantages

Consideration must also be given to the constant problem of light plates and more welding, as against heavy plates and less welding. Is it better to effect a structure of several light plates properly located, or have two or three heavier plates and consequently less welding? Each plan has its distinct possibilities and advantages. Design and strength being equal in both instances, the determining factors should be the cost of more welding against the cost of heavier plates, and, second, the possible machining time that can be saved either way.

If one heavy plate can combine several expensive bosses, and perhaps a necessary machining pad, there is no doubt but that it should be used. In many cases this heavy plate also provides needed additional rigidity. The strength of the material we are dealing with has been allowed to cover too many sins. Rigidity should not be mistaken for strength. Each is an individual characteristic, and the structure should be so designed as to receive the greatest benefit from both.

Light plates are highly effective for ribbing and for use wherever support plates are necessary. If forming facilities are available, bent plates should be used. These have three advantages: torch cutting is eliminated, welding is reduced to the minimum, and the product itself is made better appearing. This elimination of extra welding is a step toward realizing the ideal construction—that is, a welded member with very little welding.

When using light plates for cross ribbing, it is often better to rough plane these to the inside dimension, so that not only is lining up made easier, but a straighter, much better structure is the result. Hence, time is saved in machining, because it is possible to control the amount left for finish, and very often only one finish cut is necessary.

Temporary Cross Ribbing Is Helpful in Preventing Warpage

Overhanging plates should be avoided wherever possible; and if they are absolutely necessary, they should be well supported with ribs or triangles. Every effort should be made either to discourage, or at least allow for, pulling over during a welding operation. As in the case of steel castings during the pouring operation, temporary cross ribbing should be resorted to. These ribs tend to hold the member straight while welding is being done, and they can be cut away when the structure has cooled off, after which the structure may be stress-annealed. The method of applying these temporary cross ribs may be worked out with the man supervising the tack weld-

ing. After the structure has been tacked together, it is good practice to go over it thoroughly, not only for a final check on design, but to make certain that it will hold its shape in the process of welding.

The designer must consider the possibilities of constructing the main members in such a way as to leave a minimum amount of scrap in torch cutting. Very often a slight change in the shape of a large housing plate will permit several smaller plates to be cut from the same stock.

There is another important factor in reducing costs, and one that must be considered in any welded structure of considerable weight. It is the combining of steel castings with steel plates to the best advantage of the structure with regard to design, construction and economy of manufacture. Whether to weld or to cast, is far easier to decide than whether to use steel plate only, or to combine the two.

Three Factors Determine Choice Between Plates and Castings

It should not be very difficult to determine whether the design or structure warrants cast-steel or welded construction. To begin with, the first consideration should be quantity. If there are only one or two, or half a dozen involved, the pattern cost could not be spread over enough units to warrant the use of cast steel. If a greater quantity is desired, and the member is not too cumbersome or large, then cast steel would probably be cheaper. Even with the greater quantity, however, there are two other factors to consider.

One is the element of time, and in many cases this is the deciding factor. In welded construction, it is possible to have the entire member cut, welded, normalized and machined before the pattern is made.

The other factor is the equipment which the shop has for handling a general run of welding work. If the shop has proper rolling and forming machines, then the cost of cutting and welding is reduced sufficiently that even on very small members the cost is far below that of steel castings. For example, with a forming machine, it is possible to bend up a box section from one piece of steel, and only leave one place to weld, thereby saving three torch cuts and three welds. Moreover, a bent-plate structure having rounded corners is much better appearing than a cast-steel structure.

In heavier members, weighing several tons, the choice of using steel plates or steel castings is easily made, since the quantity would be naturally limited, and the pattern cost would be prohibitive. Even were the pattern cost entirely disregarded, one must consider the fact that in heavy structures the welded member would be the stronger of the two, since it would be more homogeneous, and would certainly not have any blow holes in the heavier sections. If further inducement is necessary before making this choice, the cost-per-pound method of figuring should suffice. Since the design would be almost identical in the two, it is only a case of estimating the weight of steel castings at so much a pound, against the estimated weight of the steel plates plus the cutting and welding costs. Invariably, in heavy members, the construction will favor welded plate design, since it is only a matter of using so much plate at about 2 cents per pound as compared to steel castings at triple this cost or more.

If the analysis designates the use of a steel casting, the subject is closed. However, if welded design is decided upon, then the structure offers other problems which can be handled in one or two ways: it may be entirely constructed of steel plates, or it may consist of steel plates and steel castings, both combined into a rigid unit showing the greatest benefit from the design. The problem is to determine just exactly where and why a steel-casting insert should be used, instead of building up these small sections of welded steel and inserting them in their proper places.

Steel Castings Have Advantage If They Simplify the Design

Steel castings should be used in combination with welded steel when the general design as a whole will be greatly simplified by their use—for example, where a single, simple casting can replace many smaller pieces. Although small pieces of scrap may be used in constructing this one item in question, such construction may still be more costly than the use of a steel casting. To begin with, no matter how much scrap a firm has on the floor, there is seldom a piece that can be used without additional torch cutting. Furthermore, it is always costly to handle small pieces since they often must be beveled by a hand torch before welding, and then finally cleaned up and the rough spots chipped off before tacking to the larger unit.

As an example, let us consider the side of a small structure resembling a speed reducer with three parallel bores. In order to provide proper bearing for the three shafts, it is only natural that the member be provided with bosses of sufficient length to support these shafts. In the welded design, it will be necessary first to cut off these bosses by saw, face them in the lathe, rough drill them in a drill press, and finally tack them in place. More often than not, these bosses will have to be supported with suitable triangles or ribs. Moreover, they involve labor aside from the cutting and welding departments, and this labor is often overlooked.

If a light steel casting were used, it could be so designed that the three bosses would be combined into one member by means of three ribs. The holes could, of course, be cored and so save valuable machine-tool labor. In this instance, by combining the three bosses into a flat plate casting, the piece can be welded in place without concentrating the welds in a small area, as would be the case with three single bosses. It all sums up to the fact that if we can save the labor of saw cutting, facing in the lathe, drilling, and additional torch cutting, by using a simple steel casting then it should be used.

Again, let us consider a heavy steel welded member having certain bearings that are of the split-cap design. We will assume that these bearings carry unusually-large-diameter shafts, and that each bearing is about 12 in. long. To build this bearing of steel plates, it would be necessary to weld a half ring on each in order to provide proper tool clearance when facing the ends of the bearings. After these plates have been welded together, the unit will, no doubt, have to be rough machined before it can be welded into its proper place.

Against all this fitting of plates and rough machining, a single steel casting is more favorable, not only from the standpoint of lowered cost, but also because it is probably stronger, since in this case it is more homogeneous.

Costs Can Be Figured on Basis of Total Weight

If we disregard the strength of either material, they can both be easily figured for cost. It is only necessary to take the estimated rough weight of the several pieces of steel at 2 cents a pound, plus so many feet of welding, plus time necessary for rough machining and tacking, against the estimated weight of the steel casting at so much per pound. Even if the figures slightly favor the welded design, the casting should be used for the reasons already mentioned.

Aside from general illustrations and examples, it is rather difficult to set down definite rules of just where to use a steel casting with a steel plate, or where to use steel plate exclusively. The primary consideration should be *cost*, which is only a matter of figuring estimated weights and their respective costs per pound. Second, there is the possibility of simplifying the handling of the design by combining several small pieces into one cast-steel member. Third, as in the case of a bearing seat, the casting would be favored because of strength. It does not follow that a steel casting is stronger than the plate, but in some cases where the casting is one piece and the welded member probably four or five pieces, the casting will answer the purpose better.

Hard-Facing *vs.* Plastering . . .

By MILES C. SMITH

NOW that hard-facing is well along in the second decade of its existence, one would suppose that misapplication, the use of the wrong material and careless workmanship couldn't possibly be the reasons for present-day failures, but they still remain so. With hundreds of welders, hard-facing has become an art, and its successful applications have been responsible for the steady inroads made by hard-facings or weld-on overlays. However, there still is a large army of heedless, careless, inadequately informed fabricators and welders who condemn one of industry's most valuable processes solely because of their own lack of knowledge or care, or both.

When we seriously consider the purposes of this particular class of welding and the types of applications where it is usable, we can readily see why it is wrong to assume that a hard-facing is any sort of material which may be formed into a hard deposit by the oxyacetylene flame or the electric arc. To be successful, a hard-facing must be of such a quality as to meet and fulfill all the requirements of a specific application, and it must, at the same time, be sufficiently well bonded to and supported by the parent metal to insure that it will stay in place and function.

To grab up and use just any so-called "hard-facing" is as ridiculous and as much out of place as to use brass for any machine part which may present itself. Ordinarily, hard-facings are applied to resist wear or corrosion or both. They effect an economy over making an entire part of some metal or substance which will successfully perform in the service to which only a small portion or area of the part is subjected. By adopting the use of a hard-facing, the section of the machine or machinery part most exposed to the ravages of wear or corrosion can be adequately protected, yet the part as a whole may be made of much cheaper metal. It sounds easy, but as all who have tried the procedure know, there is, as we say, "a lot to it."

After an examination of hard-facing applications of various and sundry sorts, one must conclude that many welders do not understand, or else they ignore, the primary factors entering into this phase of welding. The mistaken opinion that hardness and wear-resistance go hand in hand is still quite prevalent, even though we see concrete evidence on every side proving that such is not the case. Also there seems to be much lack of knowledge of the very fundamental physical characteristics of metals of any and every sort. For example, we find instances where hard-facing overlays are built out without support and are depended upon to resist fracture far beyond the physical possibilities of any metal of much less hardness and greater strength than the hard-facing deposit. Also, we see hard-facings fail because of misapplication and the poorest kind of workmanship.

To form a hard-facing or welded-on overlay with the oxyacetylene flame or the welding arc, both the overlay metal itself, and the parent metal to which it is to be applied, must be understood at least to the point of knowing the physical characteristics of each under the influence of heat and cold.

Parent Metal and Overlay Must Expand and Contract Together

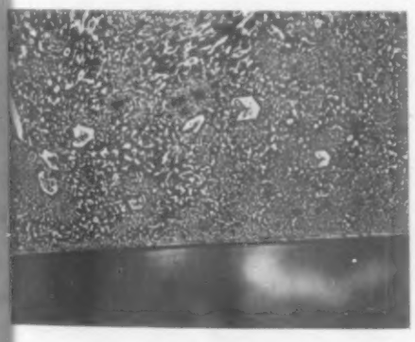
If the overlay metal has a much different coefficient of thermal expansion than the parent metal, trouble may be expected, because after all is said and done, a welded-on overlay or hard-facing is nothing more than a casting which is poured on the parent metal and allowed to cool from the liquid state to a solid while bonded to the parent metal. If the shrinkage of the overlay, on cooling, is materially greater or less than the shrinkage of the parent metal to which it has become attached, checks and cracks may be looked for in the overlay deposit or may be expected when the overlay deposit goes into service, or strains may be set up which will cause the parent metal to fail.

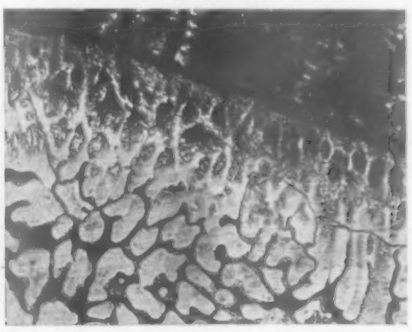
Another consideration which seems to escape the notice of the average welder is that certain welded-on overlays do not bond well with certain parent metals. In this day and age when alloys, many of which are very complex in composition, are used so extensively, a welder must stop, look and listen before applying a hard-facing. Some of these new alloys have peculiar physical and chemical characteristics, any one of which could interfere with successful hard-facing.

Stainless Steel Is One Example of Difficult Metal to Hard-Face

As concrete evidence of this, one need look no further than the popular 18-8 stainless steel, which has a low rate of heat conductivity, a high thermal coefficient of expansion, and many other characteristics not found in ordinary carbon steel. Should one try to hard-face stainless steel with "just any hard-facing," one would run into considerable trouble. Yet there are hard-facings, several of them, which may be successfully used to form a wear- or corrosion-resistant welded-on overlay upon this and other varieties of merchant stainless steel.

Then there is the bonding to be taken into consideration. If the hard-facing is not well bonded to the parent metal, it is worthless, and not all metals of unlike composition will readily interalloy or bond under welding conditions. In the hard-facing operation, there is no opportunity to completely fuse the parent metal and the overlay metal under ideal conditions and puddle the two together. The bonding or interalloying must occur along the line of contact between the two, and any recognizable dilution of either the overlay deposit or the parent metal must be guarded against. If the overlay deposit be diluted by the parent metal, it will lose at least a part of its desirable proper-





Photomicrographs of Welded-On Overlays.
(The view at the left shows no bond between the parent metal and the overlay deposit, while the view at the right shows an excellent bond although there is no evidence of dilution. Original magnification 50×, reduced ½ in reproduction.)

ties, and if the parent metal should become saturated, even partially, with overlay metal, it will probably lose its physical strength and other desirable characteristics. So, an overlay metal which will bond as and where required to a given parent metal must be chosen for each parent metal. One can't simply select an overlay metal to one's liking and use it everywhere and anywhere and for any and everything.

During the earlier days of hard-facing's existence, there were but a few such materials available, and their performance was so outstanding in comparison with the performance of unprotected metal that one kept his eyes closed to the greater part of the deficiencies of the process. Then, too, complex alloy metals had not come into more or less general use, so the bonding and shrinkage were not so much of a problem. Now, however, with new metals being adopted for all manner of purposes, and with more and more being asked and expected of machinery and equipment, the welding on of abrasive-resistant and corrosive-resistant overlays has become a science, requiring both study and preparation. Many welders who feel they have successfully hard-faced in the past, now realize that they are unprepared to cope with existing conditions.

We could, if it would help any, classify parent metals into groups and do the same with overlay or hard-facing materials. We might say, for instance, that the lower-carbon steels fall into a class of parent metals which may be quite successfully hard-faced with practically any of the present-day hard-facing materials, the selection of which, generally speaking, narrows down to the characteristics desired in the overlay without giving thought to bond or thermal expansion.

Alloys Require Other Treatment Than That for Low-Carbon Steel

When it comes to the hard-facing of alloys, however, we run into something else. Now, many factors must be taken into consideration, and the ordinary iron-base, high-chromium, manganese, silicon, tungsten hard-facing rod won't always fill the bill.

The hard-facing material must be one which will bond with the alloy, expand and contract with the alloy, and not poison or change the physical characteristics of the alloy, to say nothing of retaining its own properties.

Of late, an entirely new line of hard-facing materials have put in an appearance and they have proved to be as well adapted for use with most alloy metals as with the carbon steels. These hard-facings are remarkably simple in composition, containing only a small percentage of an entirely new metallic-boride crystal and a single base metal, yet they have a relatively low melting point and may even be used to hard-face copper or brass or certain bronzes, as well as the various metals in the steel group. Aside from these, there is not, to this author's knowledge, any other such universal hard-facing material. For alloy hard-facing, if the welder doesn't resort to the use of this mentioned line, he must select with utmost care.

In the processing itself, assuming that the proper hard-facing has been selected for the parent metal, the welder often runs into trouble through lack of knowledge of the proper procedure. Many hard-facings such as those manufactured of the new metallic-boride crystals have an exceptionally great affinity for ferrous metals. Consequently, it is only necessary to heat the parent metal to a brazing heat and deposit the liquid hard-facing in place. By this method a sufficient bond between the parent metal and the welded-on overlay is formed, and there is no dilution of the overlay which could occur when the overlay is puddled in with the parent metal. There are hard-facings, however, which are designed to be puddled in with the parent metal to some extent and which form a bond only when the parent metal is liquid on its surface or skin. This brings out the necessity that the welder know his materials.

Porosity Results From Dirty Metal or Wrong Application

Porosity, which still seems to be a bugaboo of hard-facing, usually occurs because the hard-facing metal is misapplied or is applied to dirty parent metal or parent metal which boils or gives off gases or which has been subjected to too much heat. Porosity means gas inclusion, and in order to prevent porosity the welding process must be such that there is no possibility of gas generation.

Hard-facing, in so far as the welding operation is concerned, is quite a different procedure from strength welding and should be so treated. With the oxy-acetylene flame as the heat agent, oxidation must be guarded against, so the flame should be a strictly neutral one or, to make sure, slightly carbonizing. With the metallic arc, the greater heat is desired on the electrode and not on the parent metal, so, with d. c. generating units, reversed polarity should be used—that is, the positive pole should be the electrode. In either case, the object is to form an overlay or casting and not a strength weld, and care must be exercised to do just that.

As a rule, these hard-facings or welded-on overlays have little inherent strength or resistance to fracture. They are hard and relatively brittle, so they should be well supported by the parent metal and not depended upon to resist pressure by their own strength. Often times it is desirable to build out corners or form thick overlays which must have a square corner. In such instances an electrolytic-copper backing up plate or form will be of great assistance. However, hard-facing built out beyond its supporting parent metal is seldom of little purpose unless the overlay is applied for corrosion-resistance only or in applications where there is but little pressure downward or outward.

Reheating and patching overlays is a study in itself, with the average hard-facing. Metallic-boride-crystal hard-facings will permit of this; but the average chrome-nickel-tungsten hard-facings lose their desirable characteristics under a second melting, and patching an overlay formed of them is usually impracticable, sometimes impossible. This same fact holds true in the case of building an overlay over an overlay or refacing a worn hard-facing.

Heat Must Be Watched When Using the Metallic Arc

When the metallic arc is used to form a hard-facing, the operator has little control over dilution and several other factors that enter into the operation. The heat of the electric arc fuses the parent metal to an appreciable depth, and the hard-facing is thereby diluted to a certain extent as it is formed into an overlay. However, if the welder is careful to adjust the heat or amperage of his welding machine so that only enough heat is used to deposit and form a bond, he may eliminate much of the trouble. The electric-arc method of hard-facing is generally conceded to be faster and cheaper than hard-facing with the oxyacetylene flame, but the control of the overlay's formation is by no means as good. The same hard-facing material will form a much harder, much purer and more effective overlay with the oxy-acetylene flame than with the electric arc.

The whole thing simmers down to determining what the hard-facing is supposed to accomplish. If all that is required is to plaster a coating of hard, fairly-wear-resistant metallic overlay upon a machine part, and porosity, checks, cracks or evenness of surface or deposit are not a factor, the welder may take a stick of cast iron and deposit it with the electric arc at a surprisingly low cost. It may crack in service, it may even chip off in spots, but it will be wear-resistant to a considerable degree and will answer many requirements.

On the other hand, if an overlay is desired that will be solid throughout, stay in place, and function as it should, then the welder must select one of the more-expensive alloys and apply it with care. Little by little, such hard-facings have won their way to becoming integral parts of new machinery and equipment and their use has proved remarkably

economical. We could cite a long list of machine parts which leave the factory for the first time hard-faced, thereby prolonging their useful lives far beyond the wildest speculations of a few years ago.

So, the welder may or may not extend his usefulness to industry as he sees fit, but, if he does elect to weld on overlays or to hard-face, he must prepare himself to do the work skillfully. He can't be just a plasterer of metal and be of any benefit to himself or his branch of industry. Every recognized manufacturer of hard-facing materials will gladly give the general coaching as well as the specific schooling necessary to successfully use any of his particular materials, and all the welder needs do is listen attentively and be guided by the information received. Each manufacturer will be glad to supply useful information about his own products and, with all these data at his command, the welder should have little difficulty in making the proper selection.

Insofar as parent-metal qualities and characteristics are concerned, they are equally easy to obtain. Always bear in mind that the parent metal will be heated at least to a brazing heat or perhaps until its surface is fluid, and while at that heat the liquid overlay metal will be deposited. Then the overlay and the parent metal to which it has become attached will cool together and shrink together. Any great variance in the rate of shrinkage of the two spells trouble, if there be no other mistakes made.

This author's advice to any welder who has had or is having difficulty with his hard-facings is, first, to analyze the factors present and ask himself:

Analyze Your Problem by Answering These Questions

Is the hard-facing material being used, the proper one for the particular parent metal at hand?

Am I using the proper application method? If the oxyacetylene flame is being used, should I use the metallic-arc process? Or vice versa?

Would another material be easier for me to apply?

Can I obtain the desired service from the hard-facing material I have selected? Is corrosion present as well as abrasion? Is there a possibility of electrolytic action? Will the overlay get hot—if so, how hot—in service?

Must the part be hard-faced again after it has worn down in service? If so, will it be possible to do it with the selected hard-facing material?

After these questions and others which may come to mind have been answered and the necessary changes, if any, made, the welder's next step is to perfect his own technique. He should slowly and painstakingly apply hard-facing material until he can well be proud of his workmanship. Ninety-nine out of one hundred condemnations of the hard-facing materials used are solely due to lack of care or skill on the part of the welder. True, some hard-facing materials are more effective, easier to apply and more satisfactory in service than others, but all of them may be applied quite successfully, provided the welder uses the proper technique.

Hard-facing is practicable and useful and is here to stay; and as welders become more proficient in hard-facing applications, the more important will they be to industry and the further will this branch of the metal-working industry advance.

Flame Cutting 18-8 Stainless Steel

By FRED JUDELSOHN
Supervisor, Air Reduction Sales Co.

An Eastern steel company had a considerable amount of stainless steel off-analysis billets and scrap ends of plates that had accumulated owing to the difficulty of cutting them into sizes small enough to enable getting them into the furnace for remelting. The company had been sawing them, but this was an expensive operation, as this material has to be annealed first and even then it is very hard on the saw.

It was then found that flame cutting, using the oxyacetylene process, would reduce costs very materially. By this method, a 13x13-in. billet was cut into two pieces in five minutes, using 90 to 100 lb. oxygen pressure and about 10 lb. acetylene pressure, with a tip having a cutting orifice corresponding to a No. 20 size of twist drill and four preheating orifices. The cost for flame cutting was about $1.10, including gases and labor, while it was estimated that it would have cost at least $20 to saw-cut the billet.

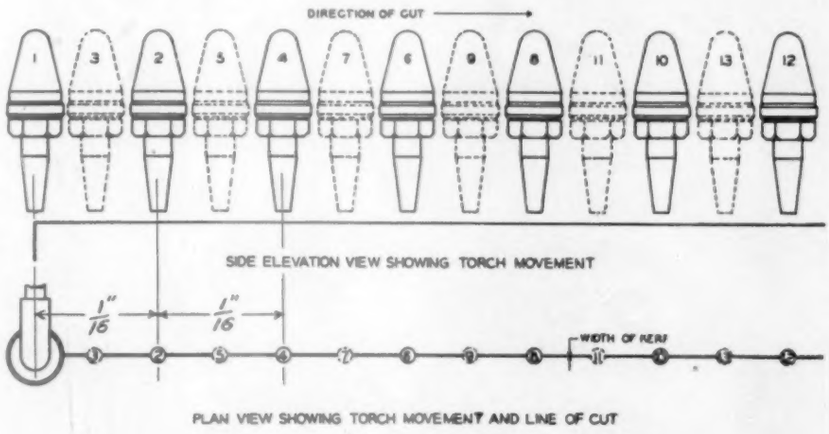
With flame cutting, a slab 5 in. thick and 30 in. wide was severed into two pieces in 10 minutes, using 75-lb. oxygen pressure and 8-lb. acetylene pressure, with a tip having a cutting orifice corresponding to twist-drill size No. 35.

The flame-cutting procedure was not unlike that used for cast iron. However, a neutral flame seemed to give the best results, the carburizing flame not working as well. The trick is in the manipulation of the torch. While in cutting cast iron the torch is moved in semi-circles, or half-moons, along the line of cut, when cutting stainless steel the torch is moved back and forth along the line of cut, always in a straight line, as explained in the diagram.

The cutting-oxygen pressure is left on all the time, as the best results seem to be obtained when the movements are made at about 60 cycles per minute, actual timing. Hence, the actual cutting action is intermittent. The cutting is much easier after some heat has gotten into the piece.

On the heavier thicknesses, it is advantageous to heat the front edge of the cut before starting. A flux rod is not necessary. On thick pieces, there is a drag of about 3 in. at the start of the cut, but this is soon picked up after getting into the piece a short distance. The angle of the tip to the work is exactly the same as when cutting ordinary steel. The kerf is about ½ in. wide.

After the operator gets more experienced on this job, there is no doubt that the tip sizes and pressures will be reduced. However, the job was started on the theory that lots of heat was necessary as well as lots of oxygen at comparatively medium pressures.



Manipulation of Torch When Cutting Stainless Steel.

(The numbers represent the several positions of the torch in sequence of movement. The torch starts cutting at the edge of the material, at *1*, and is moved forward in the direction of the cut to position *2*. The distance from *1* to *2* is about 1/16 in., this being about the longest cut that can be made with a single forward thrust of the torch. The torch is then moved backward to position *3*, this distance being anywhere from 1/32 to 1/16 in. Then the torch is moved forward again, proceeding to position *4*, cutting 1/16 in. of metal from position *2* to position *4*. From position *3* to position *4*, the torch moves along the previous cut as far as position *2* and cuts new metal from here to position *4*. The torch is then brought backward from *4* to *5*, and the operations proceed as before, always keeping the torch moving to and fro along the line of cut.)

Production Welding of

Light-Gauge Tubing . . .

Paper read at the Purdue University Welding Conference, Lafayette, Ind., Dec. 10-11, 1936.

By JOHN DOUGLAS
Electrolux Unit Division, Servel, Inc.

IN THE production welding of light-gauge tubing, there are three points which we consider the most important: (1) training of men, (2) source of supply of welding gases, and (3) production facilities.

Welding plays a very important part in the manufacture of our gas refrigerator. In fact, it is very doubtful whether it could be made at all, at least on our present production basis, without welding. By any other method, the cost of manufacturing would be so great as to result in little or no demand for it.

It is very essential from the standpoint of economical operation that the unit be made from various sizes and shapes of tubing and shells. Also, the design requires that we be able to enter or butt one tube against another at various angles. To fabricate this unit by any other method than welding would be very difficult and expensive.

Another reason for welding is that all joints must be leak-proof. These units are tested and checked with 900-lb. air pressure for leaks, although the operating pressure of the unit is less than one-third that amount.

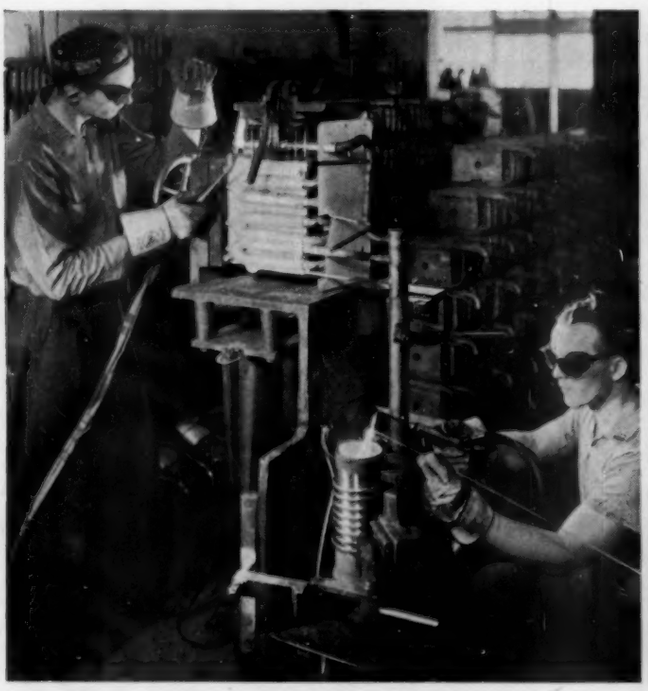
Only One Failure in Every 15,000 Welds

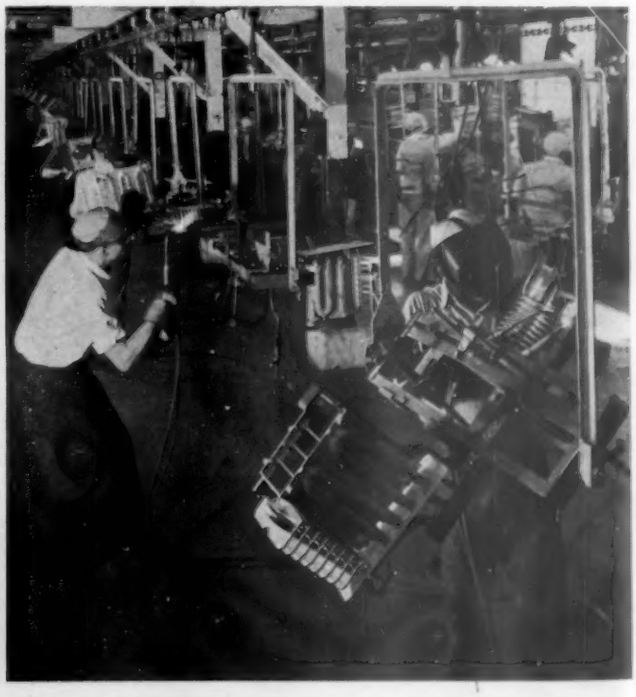
Owing to our extensive check-testing and improvement in welding and manufacturing methods, we are able to hold rejects of these units in service to less than ½ of 1%. That is, we have only one failure out of every 15,000 welds.

One of our greatest problems has been the training of men. We are faced with the necessity of training more than 95% of our welding force. As this particular type of welding is very difficult to do, there are very few experienced welders who can handle it, and even many of these must be given special instructions and coaching.

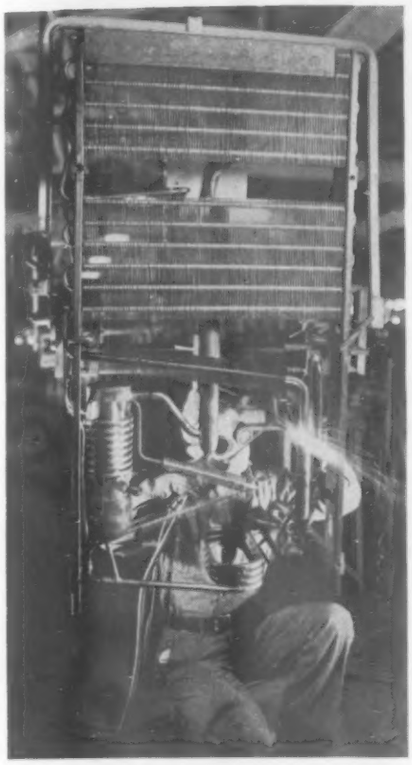
Our company employs about 500 oxy-acetylene welders. About 400 of these work in one department—the unit division. About 80 welders are employed in welding sheet-metal refrigerator liners and cabinet shells. This large force of welders has been built up over a period of 8 years. With this large a force, we are obliged to follow an extensive training program.

Up to four years ago, the students received all their training in the plant. This training consisted of two weeks' practice, and 12 to 15 were given instructions at one time. This was a slow and expensive method, inasmuch as a certain number would not be capable of learning, and some others would lose interest and quit. If at the end of two weeks the student had not shown much progress, he would be given additional training or laid off, and the process of training another one repeated. When a student is dismissed, a certain investment is lost, represented by the wages paid him during the training period, the cost of the gases he consumed and the cost of instruction.





The Major Unit Assembly Is Tack Welded in a Cast-Iron Jig (Left) After Which It Is Clamped in a Rack (Right) Suspended From an Overhead Chain Conveyor for Final Welding.



Finish Welding the Complete Unit.

Production schedules were often jumped up and sometimes doubled at short notice, which made it very hard to break in a large number of welders in time to meet the schedules.

We have trained and now employ about 30 female welders. We have found that they make good bench welders on small parts and also on liners. However, the labor turnover of female welders is about twice that of male welders, and at present we are training only enough to replace those who quit.

Local Schools Cooperate in Training Welders

In 1931 we were instrumental in getting the local school authorities interested in starting night classes in welding on their vocational education program. These classes consisted of 2 hours' practice a night, two nights per week, or a total of 48 hours per semester. Equipment was installed at that time to train 20 men each semester, or 40 men per year. About 35 of these men were employed by our company that year.

The following year the equipment was doubled, and the school ran an additional semester, training about 120 men, of which over 100 were employed by us.

The same program is being followed again this year, and we expect to employ a majority of these students.

In this present setup the school furnishes and maintains the welding equipment and pays the instructor. The students must pay a welding-gas and registration fee of $8.00, which represents about one-half the actual cost. The other half of the gas cost is paid by our company as a gift or donation to the school. No student is promised a job with our company nor with any other company in the city, but they are informed that if they make a good showing they will be given a recommendation.

There is no restriction as to who can or shall attend the classes. The instructor and vocational director, however, do discourage any one from taking the course who might be physically unfit or perhaps too old to learn.

The school encourages young, alert men who have just finished high school to take this course. When these men are given jobs they usually stay, inasmuch as it is their first and the only job in which they have any training.

Labor Turnover Cut in Half

Since we have started employing this type of men for welders, our labor turnover has been cut in half. Any man, willing and ambitious enough to spend a little money and time to train himself, will make a good employee in any type of work.

The actual practice or training itself starts with a lecture of safe practice in handling equipment. An explanation of the welding gases and equipment follows, after which an actual demonstration is given. The student is then started out on welding small sheet-metal strips tacked in a 45° angle. After he has learned to manipulate a torch and flow the corners down evenly, the next step is to teach him to run a puddle on flat sheet-metal with one hand and without using a filler rod. He is kept on this until he can produce an even oscillating movement. He is then given a filler rod, and practice is continued until he can produce a smooth built-up bead on a flat surface, and then comes the joining of two pieces of flat metal. About 12 to 15 hours are required to bring the average student up to this point.

Next comes practice on pipe or tubing. He is taught to carry a puddle over a radius, turning the tubing about five times. A tube 3 or 4 in. in diameter is best suited for this practice. He is kept on this until he has mastered the degree of holding and turning his torch, getting the proper penetration and bead.

The next step is instruction on running a bead around a smaller tube setting 90° on a flat piece of sheet-metal. Short pieces of ¾- or ⅞-in. tubing and 16-gauge metal are best suited for this practice.

From this point practice of welding a small-size tube to a larger size at various angles and in different positions is continued for the remainder of the course.

We have found that these students acquire about the same training in 48 hours as they would in twice the time of continuous daily practice, and the men themselves do not become tired or disgusted and lose interest.

When the student is hired he is put on a tack-welding job. His work is carefully watched and checked by a group leader, as well as by an instructor whose duties are to check the welding and instruct at all times.

After the new welder becomes efficient and shows ability, he is put on a simple type of weld and given additional instructions. However, some develop on a tack-welding job to a point where after a few months they are able to do some of the more difficult welds.

It is much easier for us to develop a beginner into a good welder since we have adopted the principle of having each man do only one type of weld. Before installing conveying equipment several years ago, it was necessary to break a new operator in on six or eight different types of weld on each unit to avoid excessive difficulty, and every hour we had to make a close check on the welding on account of having to carry a float or bank of units; also we had a considerable number of burned or oxidized welds which had to be cut out.

Operators Get Hourly Test Reports on Their Welds

Each weld on the unit is numbered and a written report is posted daily on weld leaks. Each operator knows hourly how his welds are testing out.

The average welder will have from 5 to 30 leaks per day. If he exceeds 30 leaks for a period of a day or two, he is given special attention by the instructor, and if necessary changed to a different type of weld. We have several welders who are able to hold their leaks below an average of 5 per day, which is very good considering that the operator is required to make from 50 to 90 welds per hour, depending on the size of tubing.

We have been able to develop pride in our welders for their work, and this has been a great factor in the reduction of our leak problem, and also has helped to eliminate plugged or partially plugged welds in the unit.

When the operator gets too much penetration or allows his puddle to drop in the joint, he notifies his group leader and the unit is held and the weld cut out. It is absolutely essential that little or no penetration be made through the tubes. The unit will not pass the operating test if it has a partially plugged joint in its system. It is very important that each welder maintain and use a neutral flame. To aid and check this, an experienced welder is employed to correct any defective welding equipment and to see that the operator maintains a neutral flame.

High-quality welding rod is essential in the welding of light-gauge tubing. It must be free of all dirt and rust. It must flow smoothly and evenly under the welding flame. We use two sizes of welding rod, 1/16 and 3/32 in.

We have found that another very important point in getting good welding is to maintain constant, uniform pressure of the welding gases.

The tubing used in making parts for the unit is seamless and cold-drawn, about 35% being drawn in our own plant. This tubing is 17-gauge, annealed to 55 to 68 Rockwell C hardness. We produce tubes from ⅞ down to ½ in. outside diameter, and the remaining parts are purchased cut to length.

Some of the parts, such as caps and shells, are processed from deep-drawing strip stock.

After the parts are cut to length they must be washed to remove all oil and grease and then sandblasted with metal grit to remove scale and oxides. We had considerable difficulty in getting tight welds when sand was used as a cleaning agent, owing to the fact that small pin holes would form in the back of the puddle in the center of the weld. In welding heavier-gauge tubing or pipe it is possible to puddle or float the silicon or other impurities to the top or out of the weld, but in light-gauge tubing very little puddling is possible without getting too much penetration inside of the tube.

After the parts have been cleaned properly they are bent or formed to their required shape, then drilled, trimmed, milled, swedged, and all burrs removed. There are 55 tube parts in each unit model, of which we produce six sizes. The parts are shaped similar in the various models, but in most cases are not interchangeable. These various parts are designed to fit closely into or on adjoining parts; swedging, milling and spot-facing are used to a great extent.

Assemblies Are Tack Welded in Jigs and Finish Welded on Conveyors

In assembling, these parts are clamped in position in fixtures or jigs and spotted or tack-welded together. They are then removed from the fixture and welded either on vise stands or on conveyors. In some cases where the parts are heavy and might draw out of shape, a half or complete weld is made.

We have three types of conveyors. In one type, all welding is done on tables and stands and the material and work is placed on it and moves forward to the next operation. For this a metal mesh belt is used. All parts going into the generator or boiler assembly are processed along this line.

In one of our assemblies—the condenser and unit-frame upright—the parts are tack-welded in fixtures and placed on a platform roller-type conveyor. The work is stationary while being welded and pushed forward on rollers from one operator to another, each operator doing one or two similar welds. Owing to the welds being somewhat difficult to get at and the tubing small, only the most experienced operators are used on these assemblies.

Burnt Welds Eliminated by Making Half of Weld, Then Cooling

At first we experienced a considerable number of burnt welds on these assemblies, but have found that this difficulty can be overcome by making only one-half of the weld at a time and allowing the weld to cool before completing. This also eliminates considerable turning of the assembly, which is rather awkward to handle. In making these welds the operator must also be careful about directing his heat to prevent burning or melting the aluminum fins on the condenser.

The major unit assembly consists of the absorber, heat exchanger and evaporator, or chilling unit.

The absorber is a one-piece cold-drawn shell with an inverted cap which is arc welded on by an automatic machine with a continuous wire feed, the operator merely loading and unloading the machine. We have a little difficulty at times in getting an air-tight non-porous weld, especially at the lap of the weld.

The gas heat exchanger consists of one tube with two separate gas passages, made possible by specially designed intersealing baffles or discs.

The evaporator is a continuous welded coil tested for leaks and then hot galvanized. It is then cast in aluminum to form the chilling unit, which after it has been cleaned, machined, and the tubing cut to proper length, is assembled and tack-welded to the gas heat exchanger and the absorber shell. Extra precaution is taken to keep excessive galvanizing and all aluminum from the ends of these tubes where they are to be welded.

Extra-heavy reinforced cast-iron fixtures with hardened-steel locating pads and heavy clamps are used in tacking these parts together.

After tacking these assemblies, they are clamped in specially designed racks or hangers suspended on an overhead chain conveyor, which permit the turning of the unit at any desired angle for welding. The welds on the final assembly are made on a moving conveyor traveling at the rate of 7 ft. per minute.

Each Operator on Final Assembly Makes Only One Kind of Weld

Although this type of welding is a little difficult, the operator by doing only one kind of weld becomes very efficient after a few days. I recall one welder with 6 months' experience who in 3 days made over 1,500 welds without a single leak. These welds were made on a ⅝-in. pipe at the rate of 70 welds per hour.

Assemblies Straightened and Tubes Heated to Release Stresses

After the welds are made, these assemblies are removed from the conveyor and placed in a combination straightening and welding fixture where they are clamped and forced back into their original position and the tubes heated to release any stresses set up by the welding heat. The condenser and boiler assemblies are then tack-welded to the unit assembly.

Owing to the weight of these assemblies, all joints are half-welded to prevent warpage, and then the complicated unit assembly is placed back in the conveyor hanger and finished welded. It is then placed in a straightening fixture and the major parts checked, and sprung or forced back to their correct positions.

After straightening, the unit is placed on another conveyor for leak-testing and assembling of metal bracing strips. The first operation is a pressure rupture test, with 1,000 lb. air pressure, the purpose being to determine if any weak or split tubes are in the unit.

A text for leaks is then made, at 850 lb. air pressure, using a liquid soap solution which is brushed or poured on, coating the welds with a film of soap. The leaks show up as bubbles or a white foam, and are marked with wax crayon. The air is then released, and the weld repaired by rewelding about half the joint and adding more filler rod. An average of about three leaks on each unit is found on this first test. The unit is charged with air, tested, and repaired five different times and then given an inspection check-test. The rejects at this point are about 5%.

After the unit leaves the welding department, it is painted and the paint baked on. It is then charged with air and tested. The unit is warm when tested and the joints expanded. The leaks found are very small and the welds must be examined very closely. Some of these show up with foam no larger than a pin head after several minutes of watching. About 10% of the units leak at this point.

The unit is then charged with the refrigerating solution, consisting in part of ammonia, and sent to the test room, where it is put to a full-load-capacity test.

Detects Ammonia Leaks by Chemical Test

After the unit is in operation it is again tested for leaks. The test here is entirely different from all previous tests. The welds are wrapped with moistened paper previously treated with a chemical that reacts in the presence of ammonia. Any ammonia vapor, even the slightest

trace, seeping through a weld turns the white acid paper a reddish pink color at the leak. Many of these leaks are so small that they cannot be detected when the unit is discharged and checked again with high-pressure air and soap solution. The percentage of units leaking on this test usually runs from 2% to 5%.

All units failing to make the load-capacity test due to having a plugged or partially plugged weld in the system are discharged and the solution washed out, and the welded joint cut out and replaced. We have been able to cut down the unit rejects from bad welds at this point to less than 1%.

At every point in the production line, we find it necessary to have close, constant supervision, instruction and check on all our welding operations.

Increased River Traffic Spurs Demand for Welded Craft

Continuing a "come back" begun in 1934, Pittsburgh's three rivers, the Monongahela, Allegheny and Ohio, carried 25% more freight during 1936 than during the previous year, according to reports by the U. S. Army Engineers in Pittsburgh. This increase, made in the face of two-months inactivity in February and March, when tug boats and barges could not navigate due to the flood, accounts in a large measure for the unprecedented demand for welded floating equipment of all kinds.

Last year's total was 39,733,020 tons of freight, as compared with 30,344,405 tons in 1935. The 1934 total was 24,375,424 tons.

Two-thirds of the traffic, mostly in coal for steel mills, was carried on the Monongahela River, which amassed a record of 24,027,310 tons. This was nearly double the Ohio River's aggregate of 12,584,781. The Allegheny River carried 3,120,929 tons.

Wisconsin to Hold Welding Conference in April

The Mechanical Engineering Department and the Extension Division of the University of Wisconsin, at Madison, are planning a welding conference for Thursday and Friday, April 29 and 30, with exhibits of welding apparatus and welding materials by manufacturers, according to J. M. Dorrans, superintendent of the university's engineering shop laboratories.

Program Announced for Ohio Welding Conference

In addition to a technical-papers program to be held on Thursday and Friday, March 4 and 5, including exhibits and demonstrations, another feature of the sixth annual welding conference to be held by The Department of Industrial Engineering, The Ohio State University, at Columbus, O., will be a 3-day course in arc welding design and practice, scheduled for March 3 to 5, with lectures to be given by E. W. P. Smith, consulting engineer, The Lincoln Electric Co., and Fred L. Plummer, of the Department of Structural Engineering, Case School of Applied Science, Cleveland. There will be a laboratory charge of $5 for this course, and all registrations should be sent to the general chairman, O. D. Rickly, care of The Department of Industrial Engineering, The Ohio State University.

The program of the conference, as announced by Prof. Rickly, is as follows:

THURSDAY, MARCH 4

9 a.m. Registration. Exhibits and demonstrations.

1:30 p.m. Address of welcome, by George W. Rightmire, president, The Ohio State University.

Short talks by W. D. Turnbull, acting dean, College of Engineering, and John Younger, chairman, Department of Industrial Engineering.

"Welding as Applied to Railroads," by Clay Roberts, welding engineer, Pennsylvania Railroad Co.

"Welded House Construction," by O. H. Menke, engineering department, Hobart Brothers Co.

7:30 p.m. Exhibits and demonstrations.

FRIDAY, MARCH 5

10:00 a.m. Exhibits and demonstrations.

1:30 p.m. "The Commercial Advantages of Welded Construction," by A. E. Gibson, president, American Welding Society.

"Oxyacetylene Cutting in the Manufacture and Utilization of Rolled Steel," by Roger B. White, service engineer, The Linde Air Products Co.

"Flame Hardening," by Dr. G. V. Slottman, research engineer, Air Reduction Sales Co.

All exhibits will be located in the Industrial Engineering Building, on Woodruff Ave., directly east of the radio towers. The papers program will be given in University Hall.

Additional Steel Capacity for Pittsburgh District

The United States Steel Corp. will begin immediately the expenditure of approximately $60,000,000 in new construction and modernization of its Clairton and Braddock plants in the Pittsburgh district.

This epochal announcement, assuring Pittsburgh's undisputed supremacy in the world of steel, drew thunderous approval from industrial, financial and engineering notables assembled at a dinner in the William Penn Hotel, Friday night, Jan. 15, the crowning feature of a day devoted to the formal opening and inspection of the Carnegie-Illinois Steel Corp.'s newly completed 100-in., semi-continuous plate mill at Homestead, Pa.

President William A. Irvin, of United States Steel, startled the galaxy of distinguished visitors with the previously unheralded announcement that "Big Steel" had completed plans for pouring additional millions into its already gigantic ventures in Allegheny County as proof of its undimmed confidence in the future of Pittsburgh as the "Workshop of the World" and the steel center of the universe. Such a gigantic venture will involve the use of thousands of dollars worth of welding equipment and materials in the great Pittsburgh industrial area.

Roughly, the new investment represents an expenditure of about $45,000,000 at Clairton and $15,000,000 at the Edgar Thomson Works of Carnegie-Illinois Steel in Braddock.

Contracts will be let in the near future, Mr. Irvin stated, and, allowing 15 months for completion of the immense new installations, they should be in operation early in the summer of 1938.

Kansas Welding Conference Program Announced

One of the finest technical papers programs ever presented at a welding conference has been planned for the University of Kansas conference, at Lawrence, on Thursday and Friday, March 18 and 19. Ten papers are scheduled, and one practical demonstration, and on the evening of the second day an inauguration dinner will be held of the Kansas City Section of the American Welding Society. The program, subject to change, is as follows:

Thursday, March 18

9:30 a. m. Auditorium, Central Administration Building. Registration.

A word of greeting, by Dr. E. H. Lindley, chancellor, University of Kansas, introduced by the chairman, Prof. Frank A. Russell, of the School of Engineering.

"Application and Technique of Electric Welding," by W. M. B. Brady, welding engineer, General Electric Co., Chicago, Ill.

"Practical Utilization of Our Present Knowledge of Magnetic Flare and Arc Blow," by R. D. Notvest, consultant on arc-welding problems, Indianapolis, Ind.

1:30 p. m. Auditorium, Central Administration Building.

"Developments in Cutting of Metals by the Oxyacetylene Process," by F. C. Hutchinson, development engineer, The Linde Air Products Co., Kansas City, Mo.

"Electrode Coatings," by F. Aschenbrenner, research engineer, Air Reduction Sales Co., New York, N. Y.

"Manufacturing and Application of Welding Pipe Fittings," by F. C. Fantz, vice-president, Midwest Piping & Supply Co., St. Louis, Mo.

7:30 p.m. Fowler Shops. Demonstration of the application of welding pipe fittings in power-plant piping systems, by G. F. Dickens, district manager, Air Reduction Sales Co., Kansas City, Mo.

Friday, March 19

9:30 a. m. Auditorium, Central Administration Building.

"The Application of Welding to Petroleum Vessels," by G. Raymond, chief engineer, Black, Sivalls & Bryson, Inc., Oklahoma City, Okla.

"Facts for Beginners in Welding Engineering," by E. D. Soderstrom, associate professor, Division of Engineering, Oklahoma A. & M. College, Stillwater, Okla.

"Highway-Bridge Welding," by LaMotte Grover, office bridge engineer, Kansas State Highway Commission, Topeka, Kan.

1:30 p. m. Auditorium, Central Administration Building.

"Welding Fabrication of Steel, Alloy and Non-Ferrous Metal Tanks," by Wm. Anderson, superintendent, Columbia Steel Tank Co., Kansas City, Mo.

"Welding and Brazing of Copper and Copper Alloys," by W. C. Swift, engineer, The American Brass Co., Waterbury, Conn.

Kansas City Section, American Welding Society, Installation Address, by society representative.

6:30 p. m. Kansas City Section, American Welding Society, Inauguration Dinner, Eldridge Hotel, Lawrence, Kan.

$200,000 in Prizes . . .

for Papers on Arc Welding

INVESTIGATIONS into arc welding will be stimulated and a great deal of valuable data will be brought to light as the result of the announcement of prize awards by the newly formed James F. Lincoln Arc Welding Foundation.

TO STIMULATE intensive study of arc welding, and to bring forth valuable material regarding the process, $200,000 will be distributed by The James F. Lincoln Arc Welding Foundation among winners of 446 separate prizes for papers dealing with this subject as a primary process of manufacture, fabrication or construction in 11 major divisions of industry.

The principal prize paper will be awarded not less than $13,700, consisting of the main first prize of $10,000 and other first prizes of $3,000 and $700 given in the main and the sub-classification in which the paper falls.

By offering prizes in eleven major divisions of industry, equal competitive opportunity is assured. Wide diversification of awards is effected by further dividing each major industry into various sub-classifications, with entrants required to select in advance the particular sub-classification to which their papers will relate.

When accepted by the jury of awards as properly classified, each paper will be in competition, in its particular sub-classification, for the five initial prizes established for each such group, and from among these winners four papers will be selected to receive additional prizes. In addition, the semi-final winners in the various divisions will be considered as possible recipients of the four main prizes.

Submitted papers must describe either the redesign of an existing machine or structure for fabrication by arc welding, or present a design, in whole or in part, of a machine or structure not previously made, showing how a useful result could be obtained by employing arc welding.

In certain classifications, slightly different eligibility requirements obtain. In the division of Commercial Welding and that of Welderies, for example, owners and operators of functioning establishments may enter the competition with papers which describe details for successfully conducting such businesses.

This competition marks the first announced activity of the Foundation since its establishment, at the close of last year.

The chairman of the jury of awards is Dr. E. E. Dreese, head of the Department of Electrical Engineering, Ohio State University, Columbus, O. Papers for the competition may be entered by any person, or group of two or more persons. It is required that any contestant may enter only one paper, on only one subject, in only one of the sub-classifications listed. Also, each contestant shall have participated in work upon which the subject matter of his paper is based; and the contestant's exact relation to that work, and to the producing or developing organization, must be clearly stated. Employers particularly are invited to urge their qualified workers or associates to submit papers for this competition.

Contestants must have papers in duplicate on file with the secretary of the Foundation, at Cleveland, O., not later than June 1, 1938. Prospective entrants can obtain complete details of the rules and conditions covering awards by writing the secretary, A. F. Davis, P. O. Box 5728, Cleveland, O.

How the $200,000 in Prizes Will Be Divided

Main prizes, first			$ 10,000
second			7,500
third			5,000
fourth			3,500
Prizes in each of 11 main classifications—			
first	$3,000		
second	2,000		
third	1,000		
fourth	800		
	$6,800	× 11	74,800
Prizes in each of 44 sub-classifications—			
first	$ 700		
second	500		
third	300		
fourth	200		
fifth	150		
	$1,850	× 44	81,400
178 papers worthy of honorable mention, not receiving other prizes, $100 each			17,800
Total			$200,000

Total number of prizes, 446.

MAIN AND SUB-CLASSIFICATIONS

Automotive: 24 prizes totaling $14,200—
1, Engines. 2, Bodies. 3, Frames. 4, Trailers.

Aircraft: 14 prizes totaling $10,500—
1, Engines. 2, Fusilage.

Railroad: 24 prizes totaling $14,200—
1, Locomotives. 2, Freight Cars. 3, Passenger Cars. 4, Locomotive and Car Parts.

Watercraft: 14 prizes totaling $10,500—
1, Commercial. 2, Pleasure.

Structural: 24 prizes totaling $14,200—
1, Buildings. 2, Bridges. 3, Houses. 4, Miscellaneous.

Furniture and Fixtures: 14 prizes totaling $10,500—
1, House. 2, Office.

Commercial Welding: 14 prizes totaling $10,500—
1, Job Shops. 2, Garages.

Containers: 14 prizes totaling $10,500—
1, Contents Stationary. 2, Contents Moving.

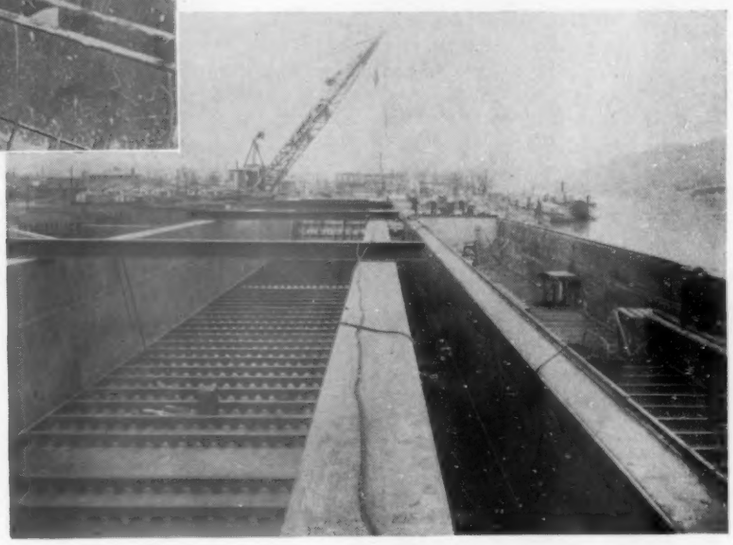
Welderies: 14 prizes totaling $10,500—
1, Commercial. 2, Departments of Plants.

Functional Machinery: 54 prizes totaling $25,300—
1, Metal Cutting. 2, Metal Forming. 3, Electrical. 4, Prime Movers. 5, Conveying. 6, Pumps and Compressors. 7, Business. 8, Jigs and Fixtures. 9, Parts. 10, Otherwise Classified.

Industrial Machinery: 54 prizes totaling $25,300—
1, Process. 2, Construction. 3, Petroleum. 4, Steel-Making. 5, Farming. 6, Household. 7, Food-Making. 8, Textile and Clothing. 9, Printing. 10, Otherwise Classified.

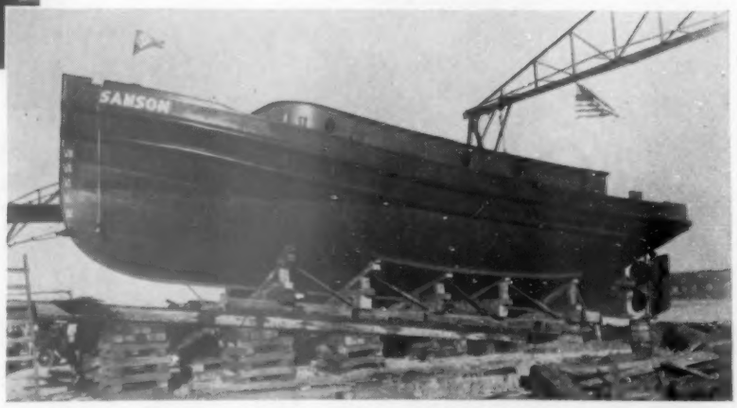
Welding News in Pictures

• *(Left)* Welding the ring segments which form the outer shell of the Midtown Hudson tunnel. This $47,000,000 welded tube, extending between Manhattan and Weehawken, N. J., is rapidly nearing completion.



• *(Below)* The second prefabricated all-welded house to be built by Hobart Brothers, of Troy, Ohio. Low in cost, it has no basements, but a unique storage attic eliminates waste space, guaranteeing plenty of storage room as well as improving the insulating and livable qualities of the house.

• A welded and a riveted barge side by side, showing their comparative construction features. The welded barge is said to be the lowest in cost, as well as the strongest. View taken in the shipyard of the Dravo Corp., near Pittsburgh, Pa.

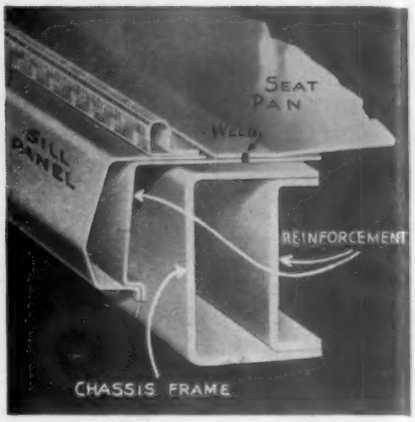


• The largest tug ever constructed in the Gulf coast district is 92 ft. long, with a 22-ft. beam and 10-ft. 4-in. moulded depth. Built by the Gulfport Boiler & Welding Works, Port Arthur, Texas. (Photograph by courtesy of The Lincoln Electric Co.)

Welding the Studebaker Body . . .

By EARL B. RAUSCH
The Studebaker Corporation

From a paper read at the Purdue University Welding Conference, Lafayette, Ind., Dec. 10-11, 1936.



Cut Section of Sill Panel and Chassis Frame With Reinforcements.

(Stiffness is secured by employing box sections. The seat pan is spot welded to an extension of the sill reinforcement.)

THE various forms of fusion and resistance welding play an important part in the manufacture of automobiles. The range of application of the arc-welding process alone is quite extensive as applied to production and to maintenance of plant equipment. It is used extensively in the construction of conveyors for carrying automobile parts to various stations to have certain operations performed and finally to the assembly line where they are built into the car.

Also, the assembly of many car parts depends upon arc welding—such as the rear-axle housing, which is made in two halves. In the early days of the automobile, the rear-axle housing was an expensive casting. Today, two pieces of sheet steel are placed in a die of the forming press and formed to the desired shape; then they are trimmed to the proper size, placed in an assembly fixture and arc welded the full length of the axle housing. The wheel-bearing support flange on many makes of axle housings is also arc welded to the end of the housing. Others are flash butt-welded.

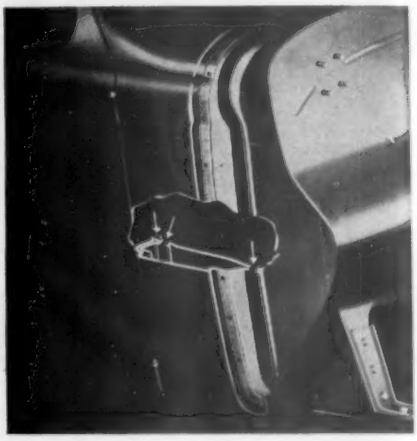
Arc welding is used to assemble various parts to the chassis frame—such as bumper brackets, fuel-tank support brackets, brake-shaft support brackets, spring-hanger brackets, etc.

The arc is also used to tack many of the reinforcements and small brackets in place in a locating fixture, after which the assembly is then taken out of the fixture and spot welded without the need of handling heavy, clumsy locating fixtures.

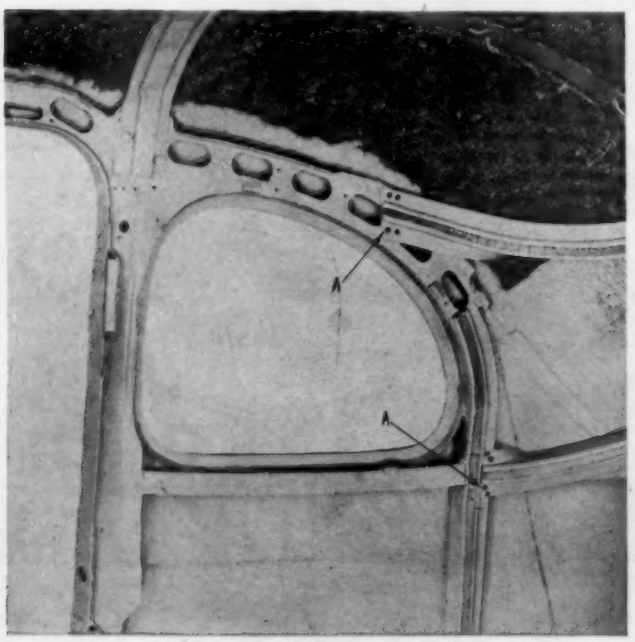
Arc welding has made it possible to make many repairs on production equipment without taking the machine apart or even moving it from its place of operation. Many repairs of this kind are made with the arc welder, and the machine or fixture is back in production in a few hours.

Of all the various uses to which electric current has been put in the last 10 or 15 years, one of the most important, from a manufacturing point of view, is electric resistance welding.

Where one or more of the various methods of resistance welding can be applied, a production problem is solved with a saving in labor, noise, dirt and



Cut Section of Cowl and Dash Panel.
(The spot welds are indicated by arrows.)

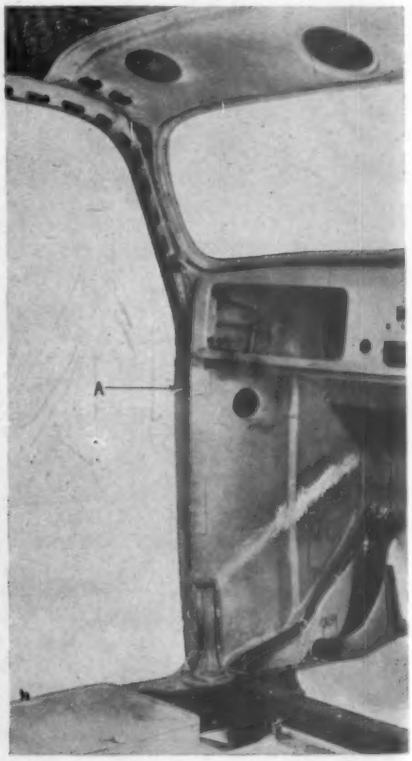


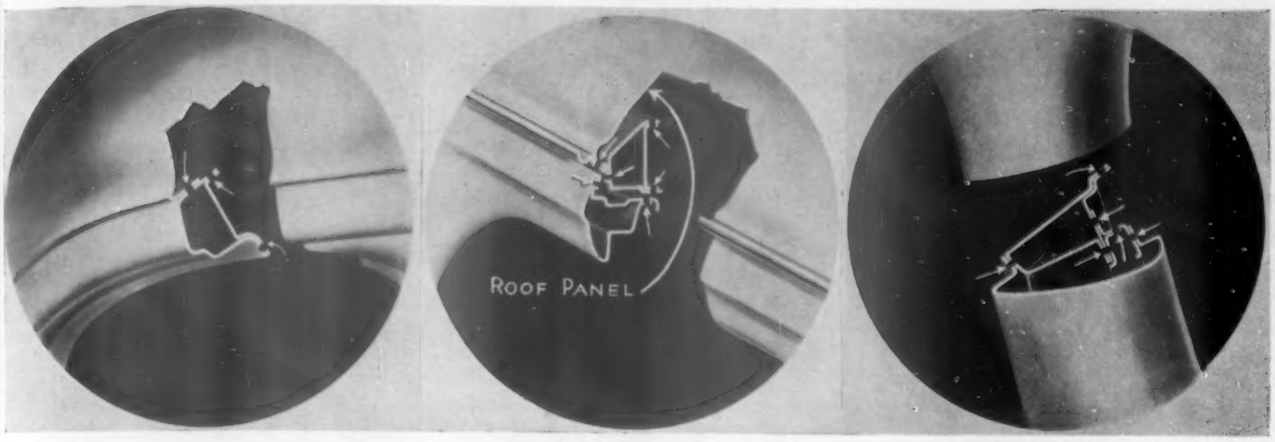
(Left) Interior View of the Roof Rail and Roof Construction Over the Quarter Window.

(The trim rails are spot welded in place as shown at A.)

(Right) Showing Roof Rail With Reinforcement, and Assembly of Side Panel and Dash.

(The side panel is spot welded to the dash at the inside of the front-door hinge pillar, as shown at A. The elongated holes in the roof-rail reinforcement permit the welding points to reach through to spot weld the roof panel to the roof rail.)





Cut Section Showing Roof and Rail Construction.

Showing Roof Panel, Roof Rail With Reinforcement, and Door Outer and Inner Panels.

Coupe Pillar Made Up to Form a Box Section.

(All sections shown are assembled by spot welding, the arrows indicating the locations of the welds.)

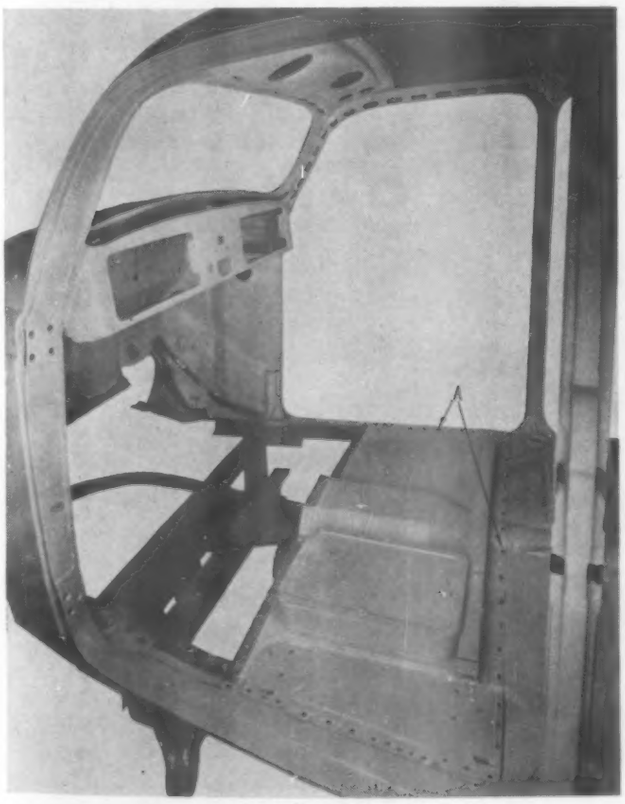
time. The resistance-welding machine is perfectly safe and simply operated. It makes joints through two or more pieces of sheet steel quietly, neatly and with amazing rapidity.

The theory of resistance welding is that the high-amperage low-voltage current flows through heavy copper conductors with comparative freedom until it reaches the work that has been placed in its path to be welded. The work to be welded offers great resistance to the current passing through it, so an intense heat is generated in the metal. Then, at the proper time, pressure is applied, which forces the metals together, resulting in a weld or union of the two pieces that is as strong as the base metal itself.

There are various types of resistance welding.

Butt-welding by the electric-resistance method consists of joining pieces end to end, completely fusing their entire cross-section. Butt-welding has a large range of application in automobile plants. It is used to weld automobile rims, automobile-body side panels to the back panels, radiator shells, automobile fenders, and many small brackets and reinforcements.

Seam or *line welding* by the electric-resistance method consists of joining lapped pieces along a continuous line or seam. By moving the joint in the path of the current, fusion is secured continuously or progressively. The seam welder has several applications in the automobile industry—one being welding of gasoline tanks. The tank is formed in two halves, with a flange all the way around each half of the tank. The two halves are then placed together, flange to flange, and placed between the welder rolls. The rolls are brought together, clamping the tank flanges, with pressure usually supplied by an air cylinder. The rolls are motor driven and act as electrodes, carrying the current to the flange. Due to the resistance of the steel, great heat is

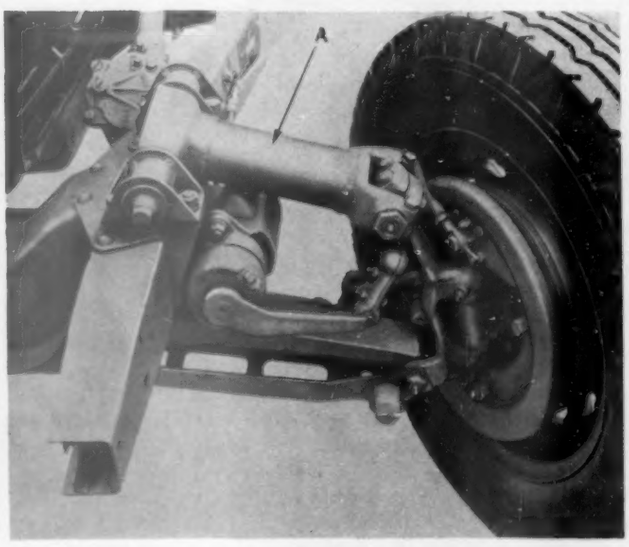


(Left) Front Seat Pan Spot Welded to Rear Floor Pan and Sill Reinforcement.

(Spot welds are shown at A. A portable welder transformer and automatic air pinch gun with 18-in. throat depth is used on this operation, doing 60 bodies per hour.)

(Below) Steering Knuckle Support Arm.

(The arm, indicated by arrow A, is made up of a piece of special tubing with forgings pressed in the ends of the tubing. The assembly is then automatically arc welded, making the three parts as one.)



generated and the pressure applied on the rolls presses the molten metal together, securing complete fusion all the way around the tank flange and making a gas-tight joint. Muffler shells also are seam welded.

Spot welding by the electric-resistance method consists of welding sheet strips, etc., in spots by bringing together and heating relatively small spots or sections of the sheets between copper or other suitable electrode points under pressure. Spot welding has a greater range of application in the automobile industry than any other method of welding. The body brackets and reinforcements are all spot welded to the body shell, the roof is welded to the side-panel roof rail, the floor pan is spot welded to the sill panels, and the drip moulding is applied with spot welding.

The entire automobile body of today is completely built with the application of arc, gas, spot, butt and seam welding. Without these methods, the cost of an all-steel automobile would be much higher than it is.

Meetings

Chicago

Leon C. Bibber, welding engineer, U. S. Steel Corp., and R. E. Long, research engineer, Hollup Corp., will be the speakers at a meeting on "The Relationship Between Weld Metal and Base Metal," to be held by the Chicago Section, American Welding Society, at Armour Institute of Technology on February 19. H. C. Boardman, of the Chicago Bridge & Iron Works, will be chairman of the meeting.

Mr. Bibber's topic will be "Relationship Between Factors Affecting Properties of Welds and the Base Metal Adjacent to the Weld," and Mr. Long will speak on "Metallurgical Aspects of Welding High-Strength Alloys." Mr. Bibber will also discuss the important work being done by the society in the development of nomenclature, definitions and symbols. Preceding the meeting, a motion picture, "Stepping Stones of the Pacific," depicting life in the South Sea Islands, will be shown.

Pittsburgh

A. E. Gibson, president of the American Welding Society and vice-president of The Wellman Engineering Co., Cleveland, O., addressed a well-attended meeting of the Pittsburgh Section of the Society, on Jan. 27.

Mr. Gibson discussed the use of welding in the building of his company's products, much of which goes into steelmaking plants. He stressed the importance of welding from a commercial standpoint, using models of rolled sections and shapes formed from plates. Lantern slides were used to illustrate his address.

An added feature of the meeting was an address by A. B. Einig, general manager of the Motch & Merryweather Machinery Co., also of Cleveland. A social hour followed the meeting.

J. D. Gordon, manager of the Fabricating Division of the Taylor-Winfield Corp., Detroit, Mich., gave an illustrated talk on "Why Use Fabricated Steel" before the members of the Pittsburgh Section of the American Welding Society, Feb. 17. All operations from the blueprint to the finished product were shown, together with views of elaborate three-dimension flame cutting and the actual welding of large jobs.

Detroit

Dr. Armand di Giulo, metallurgist, Ford Motor Co., spoke on "Metallurgical Factors of Welding," at a joint meeting of the Detroit Section of the American Welding Society and the Detroit Chapter of the American Society for Metals, on the evening of Feb. 12 in the Hotel Statler.

Los Angeles

"Alloying Elements in Welding Rod" was the subject of an illustrated talk given by T. R. Walter, manager of the Los Angeles office of The Linde Air Products Co., at the meeting of the Los Angeles Section of the American Welding Society, held on Jan. 21. This was followed by an illustrated talk by Frank C. Emery, service engineer for the Air Reduction Sales Co., on "Hand and Mechanical Oxyacetylene Cutting."

San Francisco

At the meeting of the San Francisco Section of the American Welding Society held on Jan. 22, the principal speaker was C. S. Fuller, who has charge of gas construction and operation for the Pacific Gas & Electric Co. Mr. Fuller's subject was "Welding on High-Pressure Gas Lines." K. V. King also gave his usual interesting survey of important current welding literature.

St. Louis

An open forum devoted to a general discussion of all phases of welding was held by the St. Louis Welding Society, on Jan. 15, in the Gallaudet School Auditorium. Counselors during the discussions were: F. J. Feldhaus, of the Heine Boiler Co.; R. J. Wood and L. O. Davis, of the Mississippi Valley Structural Steel Co.; F. C. Fantz, of the Midwest Piping & Supply Co.; R. J. Ryan, of the John Nooter Boiler Works Co.; W. A. McCollum, of the Atlas Aluminum Welding Co., and L. Lutke, of the Lutke Welding & Boiler Repair Co.

News of Welded Pipelines

Contracts for the following oxy-acetylene-welded pipelines have been let, according to The Linde Air Products Co., of New York City: The White Deer Pipe Line Construction Co. will lay 12 miles of 4-in. oil line for the Anderson Pritchard Oil Co. from a point near Moore, Okla., to a booster station southeast of Oklahoma City. The Skelly Oil Co. has let a contract to the Truman Smith Construction Co. for a 20-mile extension west from their 6-in. line at Lorraine, Kan. J. F. Pritchard & Co. will lay an extensive system of gas gathering lines for the Phillips Petroleum Co. in the Eunice, N. M., field, of which 45 miles will be gas welded. The B. & M. Construction Corp. will lay 14 miles of 4-in. oil line from Edmond, Okla., to Oklahoma City for the Pure Oil Co.

The Gulf Oil Corp. has started construction of its new 32-mile 8-in. welded pipeline for the Rodessa field. The line will run from the company's tank farm at Chatterton, Tex., to a booster station south of Waskom and thence to another booster station south of Cartage. New pumping units will also probably be installed.

The Union Oil Co. of California announces that it will soon begin construction of a 10-in. welded oil pipeline to extend from the South Santa Maria field to Port San Luis Obispo. A 500,000-barrel welded tank farm will also be erected in the same field.

Construction work on an 85-mile 8-in. welded pipeline from the Tilden Station (Texas) to Corpus Christi is under way by the Magnolia Pipe Line Co., and is due to be completed in February. Two 80,000-barrel welded tanks are also being erected at the Tilden station.

The Sun Pipe Line Co., of Texas, has let a contract for the laying of a 6-in. welded oil line from the Nome oil field in Jefferson County to terminal facilities at Beaumont, a distance of about 25 miles.

Visual Inspection of Welding . . .

By E. W. P. SMITH
Consulting Engineer, The Lincoln Electric Co.

OF THE various methods of inspecting welding, the simplest of course is visual inspection.

It requires experience and good observation to arrive at any satisfactory conclusions, when visual inspection is made. However, there is one characteristic of visual inspection of welds which is not true of any other type of joint—namely, you see the inside of the joint when you are making it.

Methods of Non-Destructive Inspection of Welds

Another scheme of inspection involves the use of the stethoscope. The method is the same as used by a doctor when examining your lungs. By tapping gently along the welded seam with a light hammer and listening with the stethoscope, a change in the sound shows when a fault is reached. It is necessary, of course, that the operator be trained in the use of a stethoscope so that he can detect differences in sound. On one large structural job this method of testing was used, and every joint rejected by the stethoscope was proved defective. Of course, one cannot say that every defective joint was located, but results would indicate that the method was satisfactory. The equipment is simple and rather inexpensive.

There is also the magnetic method. When magnetic flux lines are passed through the weld and the metal adjacent thereto, if the metal and also the weld metal is good, then they will indicate a certain type of pattern with iron filings or powder sifted on a piece of paper. If, however, there is a fault, this pattern will be very materially changed and, therefore, the fault may be located.

Another scheme is to subject the welded joint to magnetic flux, with a meter to indicate any variation in the flux produced by a change in the soundness of the weld. This method has been used considerably in connection with pipe inspection.

X-ray inspection is perhaps the best known. This is essentially a shadow process. The cracks, holes and porosity are indicated on the negative, which is placed on one side of the weld and the mechanism on the other. This method has, of course, certain limitations as to the thickness of the material. It is required in the fabrication of Class 1 vessels under the A. S. M. E. Boiler Code.

Another method somewhat similar to the x-ray inspection is gamma-ray testing. The gamma ray, which is a radium emanation, penetrates very thick work and therefore is used where the thickness is too great to use the x-ray.

The visual method of inspection has the advantage that it can be very easily and cheaply made.

The statement has been made that "You don't know what is inside a weld. The only way you can tell is to break it, and then if you break it you have got to do it all over again." But that is not strictly true. As a matter of fact you can see the inside of a welded joint while it is being made, and it is the only type of joint which can be seen on the inside.

Then there is the question of the human element, personal element, and all that sort of thing. Is there any operation, any fabrication process which does not involve a personal element? With the ability to see and know what you are doing, there is absolutely no excuse for poor welds. There may be reasons for them—such as poor steel, wrong kind of electrode, wrong technique, or something of that sort, but there is no excuse or alibi which should go. If the work is properly done, under proper supervision, the welds must come out right.

It's really a very simple matter to learn how to judge the characteristics of a weld. We will assume, of course, that the set-up is correct—that is, correct polarity, correct current, arc length and speed—and that a good machine and good electrodes are being used. The problem under discussion concerns, therefore, only the variables over which the operator has control—that is, the "human element."

Poor Welding Is Detected by One of Four Signs

How can you tell about these variables? There are four things which should be watched. These are:

1. The burn-off of the electrode.
2. The fusion and penetration.
3. The piling up of the bead on the work or the forming of the bead on the work.
4. The sound of the arc.

These four tell-tale signs indicate to the operator just what the trouble is or, if they are as they should be, that the weld is sound.

In regard to penetration and fusion, a word of explanation may be necessary. Fusion is the melting and joining of the metal. Penetration is the depth to which the parent metal is melted or penetrated by the operation of the arc. Proper penetration means that the parent metal is melted to a degree sufficient to result in all of the weld metal deposited being clean and of good quality, but penetration need not be any greater than is absolutely necessary to get good fusion. There are cases, of course, where penetration is imperative; for example, in a butt joint where the edges are not scarfed, a rod which penetrates deeply is very helpful. On the other hand, in the case of a scarf joint only the minimum of penetration is necessary. In both cases good fusion—that is, a good joint—must be obtained. Ordinarily, with proper penetration you get good fusion.

Individual Factors Are Varied and Effects Studied

In the method of investigation described here, only one factor at a time is varied, and then the effect of the variation is studied.

Bare electrodes are used in some of these demonstrations because they are more sensitive to conditions than are shielded-arc electrodes. Because of this sensitivity, they are used as a means of training.

The reliability of this method of inspection can be proved by performing the experiments outlined below. These should be done in your own shop, by you, or at least carefully witnessed by yourself. Merely reading these notes is not sufficient.

Referring to Fig. 1, if normal polarity is used, together with the proper current, arc length and speed of travel, the sound of the arc is a sharp, consistent crackling; the crater is deep; the bead is smooth without overlapping; and there is good fusion of the weld metal and parent metal.

Now if one or another of the proper adjustments is varied, let us see what happens. In the following experiments all conditions are to be normal except the one specifically referred to in each case. Suppose too low a current is used. The arc sound pulsates slightly; the bead piles up and overlaps; the crater is shallow.

If the current is too high, the arc sound resembles a steady crackling sound with explosions; the weld metal spatters and the electrode becomes red hot its entire length. It will be noted too that there is too much penetration—the crater is excessively deep. The bead is porous and flat.

When the voltage across the arc is low—that is, when the arc is too short—the sound is a steady sputter; the bead piles up and the crater is very shallow, as shown in Fig. 2. An extremely short arc may of course cause the electrode to freeze to the work.

If the voltage is high (long arc), the arc gives off a whistling or hissing sound plus some crackling; the weld metal spatters and very little penetration is obtained. The bead is flat. Too long an arc is readily noticeable because of these characteristics and also because a bubble forms on the end of the electrode. It will be noticed that the weld is oxidized.

Too slow speed of travel causes the arc to sputter, and the rod to become red at the tip. The bead piles up and rolls over, as shown in Fig. 3. The crater is deep. The weld takes on a bluish tinge.

Little penetration quickly identifies the weld laid with the arc traveling too rapidly. The bead is ragged and uneven; the parent metal has not been melted. The result is not a weld but merely a deposit of electrode metal on the surface.

Change of Polarity Alone Will Change Results

If the operator uses the correct current, voltage and speed of travel, but reverses polarity—that is, the work negative and the rod positive—he will see that his weld has all the undesirable characteristics. The arc will pop and sputter, the weld metal will spatter, the bead will be uneven and without penetration, and the crater will be shallow.

A little practice, varying one after another of the components of good welding procedure, will enable the operator to tell instantly whether or not he is producing a good weld, and if not just what he is doing incorrectly. By performing these tests, one will see how easy it is to tell a good, strong weld from one improperly made.

With shielded-arc electrodes and a normal current, the arc sound has a sputtering hiss with somewhat irregular cracking. The fusion is well defined and deep, as shown in Fig. 4. The coating burns deeply and there is no overlap. If the current is reduced too low, the arc sound has a very irregular sputtering and slight cracking, the fusion is shallow and the bead is on top of the plate. An increase of current to a value which is too high results in irregular explosive sounds and the fusion is deep and long, the coating is consumed irregularly, and a broad thin bead with good fusion is obtained.

If the arc voltage is reduced to too low a value, a hiss or steady sputter is noticed. The fusion is fair, but the coating touches the molten metal and does not have an opportunity to be transformed into gas and, therefore, porous beads result. The bead is on the plate and rather broad, as shown in Fig. 5.

On the other hand, if we increase the voltage to too high a value, we get a soft hiss with few crackles. The fusion is wide and deep, the electrode has drops on the end, which sputter about and finally drop into the crater. The bead is wide and there is considerable spatter.

Speed of welding has no effect on the sound of the arc. But with the speed low, there is a fair crater, as shown in Fig. 6. The electrode performance is normal but the bead is wide and considerably overlapped, and the base metal and the bead are heated over a considerable area. Note that this corresponds to the heating of the electrode part way up when you have low speed on the bare electrode.

If the speed is increased to too high a value, then we have a normal arc sound, a rather small crater, and the performance of the electrode is normal but the bead itself is small and undercut. The bead size and undercut vary with the speed and the current.

Note that in shielded-arc welding, the only case in which the weld metal is of particularly poor quality is when the voltage is too low. In all other cases the weld metal—that is, the actual metal deposited—is of satisfactory quality. However, the joint is not particularly good where there is undercutting or overlap, though the weld itself is good.

By the method outlined a weld may be inspected while it is being made and assurance given that the quality of the joint is of the character desired. It is obvious that this method of test and inspection requires proper supervision and procedure control.

Method of Inspection Should Fit Requirements

One matter that should be considered very carefully is the method of inspection to be specified.

A prospective purchaser discussing the fabrication of certain machines or structures comes to the question of inspection. He is told that there is Class 1 and Class 2, and so on, and immediately says, "I want the best there is, and

Effects of Change in Current, Voltage and Speed

Bare Electrodes

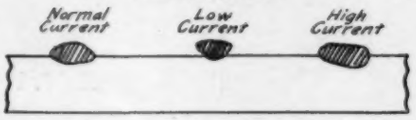


Fig. 1. Current Variations.

Current	Arc Sound	Fusion	Electrode	Bead
Normal	Steady—Sharp crackling	Good	Stable burn off	Smooth—No overlap
Low	Pulsating—"Low energy"	Poor—Shallow crater		Piles up
High	Crackling and explosions	Porous—Bad weld	(See note)	Flat—Porous

NOTE—Electrode becomes red hot along full length—Splatters.

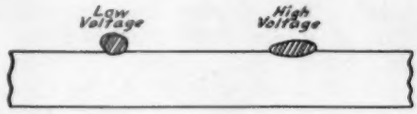


Fig. 2. Arc-Voltage Variations.

Voltage	Arc Sound	Fusion	Electrode	Bead
Low	Steady sputter	Shallow crater	Apt to freeze	High
High	Hiss and crackles	Spatter—Pockets in weld—Oxides	Arc wanders—Bubbles	Flat

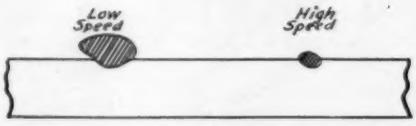


Fig. 3. Speed Variations.

Speed	Arc Sound	Fusion	Electrode	Bead
Low	Normal	Deep crater	(See note)	Piles up—Rolls over
High	Normal	Slight or no crater		Irregular—Flat

NOTE—Electrode becomes red hot at tip—not full length.

Covered Electrodes

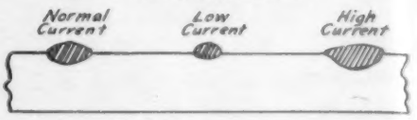


Fig. 4. Current Variations.

Current	Arc Sound	Fusion	Electrode	Bead
Normal	Sputtering Hiss—Irregular—Crackling	Deep—Well defined	Coating burns evenly	No overlap
Low	Very irregular sputter Slight crackling	Shallow		On top of plate—No overlap
High	Regular explosions	Deep—Long	Coating consumed irregularly	Broad—Thin—Good fusion

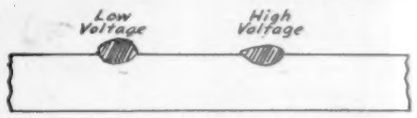


Fig. 5. Arc-Voltage Variations.

Voltage	Arc Sound	Fusion	Electrode	Bead
Low	Hiss—Steady sputter—	Fair	(See Note)	On plate, broad
High	Soft hiss—Few crackles	Wide—Deep	Drops—Flutter	Wide—Spatter

NOTE—Coating touches molten metal—porous bead results.

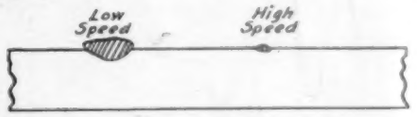


Fig. 6. Speed Variations.

Speed	Arc Sound	Fusion	Electrode	Bead
Low	Normal	Fair crater	Normal	(See Note A)
High	Normal	Small crater	Normal	(See Note B)

NOTE A—Wide bead—Overlap—Base metal and bead heated over considerable area.
NOTE B—Small bead—Undercut—Bead size and undercut vary with speed and current.

that is Class 1." Now, it is obviously a waste of money and time to insist on Class 1 inspection in all cases. The method of inspection and supervision should be in accordance with the requirements of the design.

X-ray inspection, which is a requirement for Class 1 welds, is necessary in a good many cases, but in many other cases it is not necessary. The cost to the customer is unduly increased merely because he insists on having what he thinks is the best there is, and calls for Class 1.

There must be a coordination of the requirements of the design and the specification for inspection, such that the welded equipment or structure will have an adequate service life at a cost acceptable to the customer.

Water-Supply Systems to Use Welded Pipe

By E. H. SYKES
Pittsburgh Correspondent, *The Welding Engineer*

Municipal and privately owned water-supply systems for the larger cities throughout the United States offer an attractive and expanding field for the installation of welded steel pipe, according to prominent steel-company executives of Pittsburgh, and their views are amply supported by several huge contracts now nearing completion and by other orders which are pending.

One of the largest contracts, which is virtually completed, is for the municipal water-supply system for the city of St. Louis. The immensity of this huge installation, involving approximately 9,500 tons of arc-welded carbon steel, made up in 40-ft. lengths, 60 in. in diameter, may be gained from the fact that a train-load of 200 gondola cars, each holding five lengths of finished pipe, would have been required to haul it to destination, provided the complete shipment had been made at one time.

The St. Louis contract is now nearing completion at the Leetsdale, Pa., works of the Bethlehem Steel Co., near Pittsburgh. This same organization has just received an order for similar-sized pipe for Denver's municipal water-supply system, and it is reported that Baltimore will shortly award a contract for a new water system which will probably eclipse the St. Louis and Denver orders in size.

Butt-Welded Pipe Ready to Enter Enameling Trough Shown in Foreground.

Leslie Allen, general manager of fabrication shops in the Pittsburgh district for Bethlehem Steel, believes that welding offers several distinct advantages over riveted and other forms of construction for water-supply systems. In an interview with the writer, Mr. Allen said that welded construction is not only cheaper than riveted but it also permits applying an enameled coating to the pipes, both inside and out, for preventing water and soil corrosion. This latter advantage is not possible in riveted construction, he said.

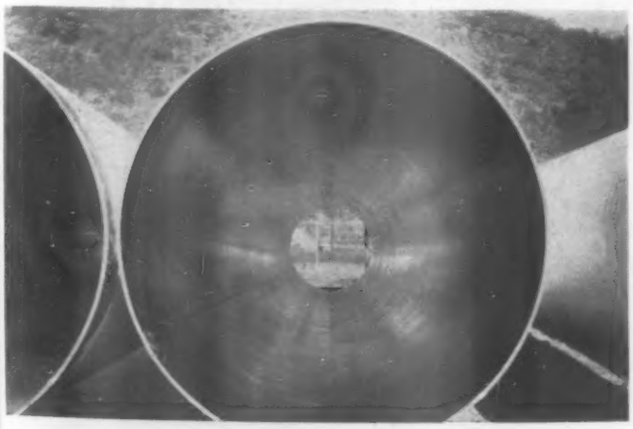
Pointing out that, with the growth of population, cities will be forced not only to transport water supplies greater distances but, because of increased requirements, to seek additional sources at remote locations, Mr. Allen visualized a vast potential market for welded steel pipe for this purpose in the years to come. In such cases, water and soil corrosion becomes an important problem. Bethlehem engineers have devised new equipment for coating the pipes, inside and out, with a coal-tar product, which, applied under heat, makes a hard, noncorrosive surface on the pipe.

The enameling equipment consists of a long trough, partially filled with the coal-tar product, in which the pipe is revolved. The inside and outside coatings are applied separately. The inside coating is applied at a temperature of approximately 450° F. with the pipe revolving at 200 r.p.m. The excess enamel runs out either end, but the turning continues, and as the pipe cools, the coating finally becomes hard and dry. The outside coat is applied very slowly in comparison, usually at 35 r.p.m.

Two orders were involved in the St. Louis contract. One contract called for 29,500 lineal ft. of ½-in.-wall pipe, 60-in. diameter, and the other for 17,400 lineal ft., 9/16-in. wall thickness, 60 in. in diameter. In addition, there were many couplings and specials.

All the pipe, which was made up in 40-ft. lengths and carbon-arc butt welded, was enameled on all surfaces, and the outer surface was then whitewashed to prevent the sun's rays from softening the enamel while in transit. Special precautions were taken while shipping to prevent scarring.

The welding operations in connection with these large installations, are very interesting. The steel plates are first cut to the proper size, after which the edges of the plates are upset, and then the units are rolled to size. The cylinders are then automatically butt welded with the carbon-arc process, first on the inside and then on the outside, after which a primer coating is applied, preparatory to enameling. Riveted pipes could not be coated.



Interior View of 60-Ft. Enamel-Coated Steel Pipe.

Coming Events

Mar. 3-5. Columbus, O. Sixth Annual Welding Conference of The Ohio State University, with exhibits. For information write O. D. Rickly, Asst. Prof. of Industrial Engineering.

Mar. 15-18. Chicago, Ill. National Railway Appliance Exhibition.

Mar. 15-19. Philadelphia, Pa., Convention Hall of the Commercial Museum. National Oil Burner and Air Conditioning Exposition.

Mar. 18-19. Lawrence, Kan. Third Annual Welding Conference of University of Kansas. For information write A. H. Sluss, Professor of Mechanical Engineering.

Mar. 24-26. Ames, Iowa. Ninth Annual Welding Conference of Iowa State College, with exhibits. For information write D. C. Faber, Director, Engineering Extension Service.

Apr. 8-11. Minneapolis, Minn., Auditorium. Northwest Automotive Maintenance Show. For information write H. H. Cory, 303 Tribune Annex, Minneapolis, Minn.

May 3-7. Milwaukee, Wis., Municipal Auditorium. Annual Convention of American Foundrymen's Association. For information write C. E. Hoyt, Secretary, 222 W. Adams St., Chicago, Ill.

Welding Tie Rods in Steam Pans

By A. M. MAC FARLAND
Consulting Welding Engineer

In connection with the fabrication of steam pans, problems arose as to the best way of welding the ends of 75,000 tie rods in the 20-gauge steel sheets to make them steam-tight, and how to make the holes to receive the ends of the tie rods.

In the first attempt, the holes were drilled through from one side, with an ordinary twist drill as shown at *1* in the sketch, giving the result shown at *A*. The holes were deeply concave on one side and highly convex on the other. The rods were inserted and gas welded. The average welding time per end was 25 seconds. The result was a tight but considerably bulged and warped job, with a rather high gas cost.

It was then decided to sharpen the drill to a long point as shown at *2*, and to use a multiple-spindle drill press with the feed entirely controlled from one handle. This speeded up the drilling time to about one second per operation, and reduced the depth of concavity. The pans were turned over and drilled from both sides, giving the result shown at *B*.

There had been some trouble with the drills heating, but when the long point was used there was no further trouble. The holes were in reality partly punched and partly drilled.

Welding was changed from gas to electric. First a carbon arc was tried, fusing down the ends of the pins. There was some difficulty in making the metal flow smoothly and avoiding occasional pin holes.

A change was made to a metallic electrode, using a medium-priced coated rod. The welding time was reduced to 10 seconds, and buckling was avoided.

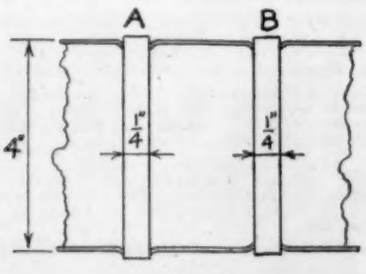
Eventually, a heavily coated shielded-arc rod was adopted as giving the best results. The welding time was reduced to 6 seconds per end, and the weld was smooth and tight. There was no warping or buckling of the plates. A 3/16-in. rod was used at 220 amperes.

The pins acquired a small burr in shearing, which prevented them from falling out of the holes. One end was touched on an emery wheel to remove the burr and point it very slightly so it could readily be inserted into the pan.

Hot-rolled ¼-in. stock was used. By accident, one lot of pins was made from cold-rolled stock, and it was noticed at once that the metal did not flow as readily and the welding was slowed up.

In welding, the arc was started on the pin head and circled around to overlap the plate just sufficiently to flow the metal onto the plate without burning through.

The holes were drilled with 1/64-in. clearance. When larger holes were made, more welding time was required to flow the metal across the gap.



Section of Steam Pan, and Drill Points Used.

Education Needed Regarding Merits of Special Steels

W. F. Detwiler, executive vice-president of the Allegheny Steel Co., Pittsburgh, Pa., believes the year 1937 will see a growing trend in the steel industry toward the production of special steels, each designed to meet certain needs, and wider use of welded stainless-steel construction by the automotive industries. In many fields already, steel is not merely "steel" but an alloy evolved by research for some special application, in his opinion.

In commenting upon the 1937 outlook and the merits of the products now available, Mr. Detwiler said:

"Through its metallurgical and engineering work, the steel industry has made outstanding improvements, but the public does not yet recognize fully the merits of the products now available. A major problem of the steel industry in 1937 therefore, is the education of the ultimate consumer to take advantage of the increased efficiency of the new steels which can be used to improve the products he buys.

"Educating the consumer involves direct contact between the steel manufacturer and the public, and consequently a rehabilitation of steel marketing methods. Based on our own experience, it may confidently be expected that when this is accomplished, both the public and the industry will benefit.

"The steel industry is alive to the need for greater contact with its final customers and 1937 may be expected to witness a growing tendency along this line.

"Another trend which is new in 1937 is the use of stainless steel in autos for increasing strength and reducing weight. Large tonnages of stainless steels have been used, and are being used for corrosion-resisting and ornamental applications to autos, but 1937 witnesses the production of cars with panels of light but strong stainless steel welded to the sides of the cylinder blocks to replace similar areas of heavier cast iron.

"There are numerous other possible uses for this material in auto engines, chassis and bodies for weight-saving, greater strength against deformation and bending, and complete resistance to weather without protective coatings. It is already being so used in other transportation fields, having made possible the construction of streamlined trains which are as strong as standard steel trains of the same size, but only about one-half as heavy. Wherever weight must be moved, as in the airplane, auto, truck and railroad train, the trend will undoubtedly be toward the increased use of weight-saving alloys such as stainless steel."

Mother of Four Likes Welding Business

Mrs. Anne McEnally, mother of four and co-partner with her husband in the Metal Fusion Co., 4017-19 Payne Ave., Cleveland, O., prefers welding to household tasks. Give her a nice bit of a repair job on, let us say, the flywheel of a stamping press, "and there," says Mrs. McEnally, "you have something.

"I don't care to spend my time darning stockings—it's much cheaper for me to buy them," said the lady, who believes that working with steel is the most fascinating business in the world and that it offers a great future for women.

Mrs. McEnally learned about steel and welding "from the ground up," from her husband, who has been in business for 15 years.

Recently there has been an increasing demand for trained welders. This resulted in many young men coming to the McEnally shop with a view to learning the trade there. So Mrs. McEnally got some instructors and started a school. Now enrolling 50 students, the school in four months grew to such an extent that it has been necessary to move it to larger quarters.

THE WELDER

By CLARENCE E. FLYNN

Cupid is not an archer,
Journeying through the land
With arrows in a quiver
And ready bow in hand.
That is a misconception.
If it was so arranged
In ages that have vanished,
It has long since been changed.

No, Cupid is a welder,
Who does his work with care.
He goes in search of business,
And finds it everywhere.
Then, too, he specializes,
Choosing among the arts
That necessary service—
The work of welding hearts.

"We can't say enough good things about Tobin Bronze"

says E. S. HEBELER of
HEBELER WELDING COMPANY
Buffalo, N. Y.

"TOBIN BRONZE enabled us to do a spectacular job for the Bayless Pulp & Paper Company, of Austin, Pa.," Mr. Hebeler states. "The shaft in the 84" dia. 42" face, main drive *cast iron* pulley snapped between the two hubs, breaking all 12 spokes away from the hubs, and all but 3 away from the rim. The plant was paralyzed and it looked like a shut-down of four to six weeks for delivery of a new pulley. We were called in, and as no distortion of the rim could be allowed because it had 18 1¾" rope grooves, we decided brazing was the only suitable and quick method of repair.

"The pieces weighing 4½ tons were trucked to Buffalo, brazed with Tobin Bronze (which we use on *every cast iron job*, whether low-temperature is a factor or not) and returned to Austin in less than one week. *We can't say enough good things about Tobin Bronze.*"

When difficult welding jobs appear, nothing quite equals Tobin Bronze! This time-tried Anaconda product carries the trademark "Tobin Bronze Reg. U.S. Pat. Off." on each rod. Look for this mark and be sure you are getting genuine Tobin Bronze! 37356

ANACONDA
from mine to consumer

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities . . . In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

What's New in Equipment and Supplies

Tapered Rod Compensates for Uneven Heat

An evenly tapered metallic-arc electrode having a smaller diameter at the starting end than at the finishing end, has been developed by the Electric Arc Cutting & Welding Co., Newark, N. J., and is available in bare, fluxed, dipped and extruded types.

This electrode, known as a "Compensating Rod," deposits more and more metal as it is being consumed, thus offsetting the tendency that even-diameter electrodes have of starting too cold and ending up too hot. Moreover, the tapering form of the rod compensates for the energy loss due to resistance in the unconsumed part of the rod.

The pointed end is said to make for fast starting, and the increased diameter at the other end prevents undue heating as the rod is being consumed. Higher current densities are said to be possible, if the work can stand being speeded up, with corresponding savings and better grain structure. Work in corners and deep vees is no longer impossible. Less voltage, and hence less power, is required, especially in starting.

Pipe-Thawing Unit Rated at 8 Kilowatts

An engine-driven generator especially designed for thawing frozen water pipes has been announced by The Hobart Brothers Co., Box U-27, Troy, O. Although this unit closely follows the design and construction of the Hobart gasoline-driven arc welder, the generator is of special design, delivering alternating current at a safe voltage for pipe thawing.

Although officially rated at 8 kw. at 1,500 r.p.m., many combinations of current and voltage are available from a proper selection of the thawing range. Such selection is made possible by the use of series or parallel control-panel connections and by varying the engine speed from 800 to 1,800 r.p.m. by means of the governor.

The unit has two thawing ranges: 500 amperes at 16 volts (series connection) and 1,000 amperes at 8 volts (parallel connection), all based on a speed of 1,500 r.p.m. The volt-ampere curves have drooping characteristics, thus tending to relieve the load on the engine and generator as the current is increased.

The generator is powered with a 43-hp. Chrysler engine, equipped with a self-starter. The governor is operated by a V-belt from the crankshaft pulley, and the speed is varied through a small handwheel.

Cement for Closing Pores in Cast-Iron Welds

"Nemco" waterproof cement, for insuring water-tight electric welds in cast iron, has been announced by the Northeast Metals Co., 4124 Torresdale Ave, Philadelphia, Pa., who claim that this cement hardens in two hours, providing a glassy surface not affected by boiling water. It is recommended for arc welds in motor heads, boiler sections, radiators and other castings, and is sold in two-ounce collapsible tubes.

Automatic Portable Spot-Welding Gun

The Progressive Hydraulic Spot Welding Gun, a portable production unit for assembling sheet-metal parts, has been announced by the Progressive Welder Co., 737 Piquette Ave., Detroit, Mich. A feature of this device is its hydraulic "squeeze action," which is said to make it easy to employ the correct pressure on the parts being welded. The high pressure available from the hydraulic booster, together with the finger-tip adjustment, makes possible the welding of the same or different gauges of metal with the same facility and results, it is claimed. The gun is self-lubricated.

The complete unit is readily installed on the production line, since only connections to air, water and electrical supply are necessary to start operation.

Using Welding Gun on Auto Body.

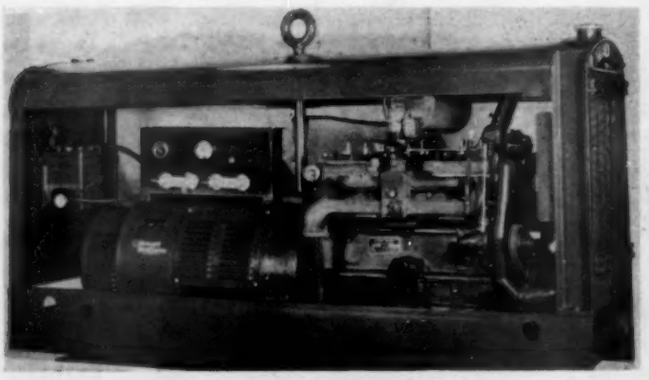
The overhead mounting of the unit on a swivel-type hanger gives a working radius of approximately 12 ft. The light, compact gun and cable assembly allows operation as far as the workman can reach without undue exertion or fatigue, and it can be used in close quarters.

The transformer is rated at 50 or 75 kva. and is water-cooled. A simple hand-operated switch varies the output to suit different gauges of material and welding conditions. The water-cooled cables, with an integral outside rubber covering, are small in diameter, though having sufficient cooling capacity, and are flexible.

The hydraulic booster, the heart of the unit, is ruggedly constructed, self-lubricated, and capable of a range of pressures from 0 to 3,000 lb.

Three types of guns are available with this unit, as well as a wide variety of points, adaptors and yokes, which will accommodate most any shape or section. The pincer, expansion and fixture bar type of hand guns cover every field of operation and, with interchangeable points and fittings, can be adapted to any production or manufacturing changes necessitated by yearly model revisions.

Proper current control is obtained by adjustable timing devices. The light weight of the gun enables it to be used without balances or cables.



Engine-Driven Generator Especially Designed for Pipe Thawing.

'Round and 'Round It Goes Where It Stops

.... EVERYBODY KNOWS

YOU may part your hair in the middle—or be baldheaded. You may bowl in the same league as the big boss—or play ping pong with your neighbor. Your name can start with "Mc"—or end with "son" . . . It's **what you know** and **how effectively you can use your knowledge** that cut the ice in the technical side of welding.

Bluffing, "politics" and plain luck are factors which you don't find in the formula for a successful welding executive. Too much is at stake for management to take any chances.

There are highly economical ways to do certain operations by welding . . . and there are costly ways. There are designs which are safe and designs which are unsafe. Recognized standards and codes must be met. Welding operators and equipment must meet definite qualifications. . . . The problems which the welding executive must answer are legion—and his answer **must** be right every time.

To get a man of unquestioned merit for these positions, management looks for proven qualifications.

To be active in the affairs of the AMERICAN WELDING SOCIETY is a strong point in a man's favor when he is being considered for employment or advancement. Management then looks on him as an expert among experts. It not only **looks** good, but it **is** good—good for the man and good for the welding industry.

Through its research organization, its Journal and its branch meetings, he can keep abreast of welding developments. This personal improvement will be reflected to a remarkable degree in the position he holds.

If you are not participating in the manifold benefits of the American Welding Society, do so at once. Don't wait for the wheel of fortune to spin your way—getting the "gong" will dampen your enthusiasm.

Full particulars may be had by writing American Welding Society, 29 West 39th St., New York City, or A. F. Davis, Chairman Membership Committee, P. O. Box 5758, Cleveland, Ohio, or THE WELDING ENGINEER, 608 South Dearborn St., Chicago, Illinois.

Join the—

★AMERICAN WELDING SOCIETY★

for Advancement

Trade Literature

Five timely pamphlets on the drying of wet electric equipment have been published by the General Electric Co., Schenectady, N. Y., for general distribution. Bulletin GEA-2571 contains "Suggestions for Drying Flooded Electric Apparatus"; GEA-2576 treats of "Drying Flooded Railway Equipment"; GEA-2575 is entitled, "Overhauling Lightning Arresters"; GEA-2574 gives instructions on "Drying Out Induction Voltage Regulators," and GEA-186 is entitled, "When Electrical Equipment Gets Wet."

"Easier, More Profitable Arc Welding" is the title of an attractive 24-page booklet issued by Hobart Brothers Co., Box U-27, Troy, Ohio, illustrating various jobs that can be handled with the Hobart 40-volt "Simplified" welder, and giving a complete description of this line of welders, including specifications.

"Fundamentals of Safety That Every Chemical Engineer Should Know" is the title of a leaflet available without charge to any company engaged in any kind of chemical work. Copies may be obtained from the National Safety Council, 20 N. Wacker Drive, Chicago, Ill.

Operating valves for the control of cylinders on resistance-welding machines, presses, forging machines, mill stands, and other equipment, are described in catalog No. 36, recently published by the Ross Operating Valve Co., 6488 Epworth Blvd., Detroit, Mich.

Welding rods and electrodes, electrode holders, handshields, helmets, goggles, brazing alloys and a general list of parts for rebuilding and repairing electric equipment are given in Electrical Catalog No. 6, issued by Autopower, 408 S. Hoyne Ave., Chicago, Ill.

An attractive file folder, properly labeled, for holding catalogs and other publications on welding, is available to all requesting one from A. H. Friese, of the Welding Engineering Co., Milwaukee, Wis.

Commercial News

New Building for Victor Office in Los Angeles

As a result of its rapidly expanding program, the Los Angeles branch of the Victor Welding Equipment Co., now occupies its third location within the last year. A modern plant has just been completed at 3821 Santa Fe Ave., in the industrial supply district.

The new building provides commodious quarters for display, warehouse, and service facilities, with a large parking lot immediately in the rear. The complete line of Victor equipment and a full line of supply items will be displayed and stocked.

The Lincoln Electric Co., Cleveland, Ohio, have announced two additions to the sales force of their Los Angeles office and three additions to the Chicago sales force. The new men added to the Los Angeles office personnel are W. R. Smith, with 10 years' experience in welding, including 3 years as foreman on the Boulder Dam project, and B. J. Brugge, formerly in the Lincoln Research Laboratory and later a welding superintendent for the Anglo-Iranian Oil Co., at Iran, Persia. The men appointed for the Chicago office are Robert A. Wilson, George Mandula and A. T. Cox, Jr. Mr. Cox was formerly sales engineer for the J. D. Adams Co., of Indianapolis.

A very successful welding clinic was held in Great Bend, Kan., on Feb. 8, when The Linde Air Products Co., in conjunction with their Purox jobber, the Scheufler Supply Co., gave an all-day program of welding demonstrations, with prizes given for the best specimens of welding and cutting. Shop operators and welders totaling 160 were present. Besides Geo. Scheufler and his crew of salesmen, there were the following men from the Linde Kansas City office to conduct the clinic: Tom Anderson, J. E. Dato, C. A. Melzarek and Phil Wade.

The Westinghouse Electric & Manufacturing Co. will move its Pittsburgh office and some of its general offices now located at East Pittsburgh to the Union National Bank Building in Pittsburgh, on or about May 1. Occupying nine floors of the building, from the fifth to the thirteenth floors, the Pittsburgh district office, subsidiary district offices and headquarters offices, including executive, legal, industrial relations, sales and accounting departments, will be centrally located in the Union Bank Building to facilitate their operations.

The Mine Safety Appliance Co. will shortly occupy the large new building which has been added to its model plant at the corner of Braddock, Thomas and Meade streets, Pittsburgh, Pa. The new building is a modern steel structure of four floors, measuring 65x177 ft., and adds 45,000 sq. ft. to the existing floor area of the plant. A feature of the erection of the plant is the high degree of safety control of all operations, which idea will also be carried throughout the plant after it is in production.

A school for the factory training of their distributors' salesmen is to be held by The Bastian-Blessing Co., Chicago, Illinois, during the week of Mar. 8. Classes will be held at the factory at 240 E. Ontario St. and also at the Medinah Athletic Club Building, which will be headquarters for the students during the term of school. Instruction will deal with the Rego line of welding and cutting apparatus and their applications in industry.

At the annual meeting of the stockholders of the Torchweld Equipment Co., 1035 W. Lake St., Chicago, Ill., held on Jan. 21, the following officers were elected: president, C. K. Anderson; vice-president, J. C. Kertchner, and secretary-treasurer, J. L. Jensen. The Board of Directors will consist of the three officers and Mrs. Alice B. Slack and A. L. Beardsley.

New distributors of "Rego" welding and cutting equipment have been announced by The Bastian-Blessing Co., 240 E. Ontario St., Chicago, Ill., as follows: W. S. Hiler & Co., El Paso, Tex., distributors for Arizona, most of New Mexico, and western Texas; Type Welding Supply Co., Elmira, N. Y.; and the Welding Service Co., 2402 Market St., Philadelphia, Pa., and Cambridge, Mass. The American Machinery & Supply Co., Omaha, Nebr., has been appointed a jobber.

S. J. Sigler, formerly in sales and development work on the Pacific Coast for The Linde Air Products Co., has opened a welding equipment and supply business at 1828 Los Angeles St., Fresno, Calif., handling a stock of equipment and supplies and offering repair service on all gas-welding equipment.

John H. Rodger, who has served since 1928 as vice-president of The Oxweld Railroad Service Co., 230 N. Michigan Ave., Chicago, Ill., has been elected president. Prior to his connection with that company, he spent 17 years with The Safety Car Heating & Lighting Co.

The Stulz-Sickles Co., Newark, N. J., have opened a branch office at 220 Dooly Bldg., Salt Lake City, Utah, and another at 3504 Rosedale St., Dallas, Tex. The Salt Lake City office is in charge of W. T. Jones, while Gil. V. Dye heads the Dallas office.

W. G. Griffith, who has been serving in the sales force of the Carbo-Oxygen Co., Inc., in the Bayonne, N. J., district, has been appointed district sales manager of the company's Chicago district, replacing R. A. Blakely, formerly district manager.

Robert Notvest, formerly welding engineer for the J. D. Adams Co., Indianapolis, Ind., has been appointed representative of the Will-Weld Manufacturing Co., Inc., for Indiana, Kentucky and Illinois.

C. M. Houck, formerly manager of the inspection division of the Pittsburgh Testing Laboratory, has been elected vice-president of this company, with which he has been connected for six years.

B. H. Payne, general manager of the Stulz-Sickles Co., Newark, N. J., and Mrs. Payne are enjoying a two-weeks' trip to the West Indies. Their return is scheduled about Mar. 1.

Charley Sutton, well-known Mid-Western salesman of welding equipment

DARK GREEN RODS
FOR HARD WEAR
BEFORE
AFTER
HERE you see a hard metal punch with beveled end, before and after being built up with Agile Dark Green Arc Rods into a straight shoulder.
With this reconstructed section this punch drove 700 1 7/16 holes through 1/4 in. 15% carbon steel and showed absolutely no sign of wear!
Agile Dark Green Arc Rods are just the thing for repairs to machining tools, cutting edges, plow shares, punches, etc. Also for cold-welding pig-iron castings. They make a clean, dense weld, produce no slag, and become glass-hard when quenched. Hardness 570-600 Brinnel.
If your welded or built-up section must sustain unusually hard wear you need Agile Dark Green Electrodes.
DEALERS: Some territories are still open.
AMERICAN AGILE CORP.
CLEVELAND, OHIO
For FREE SAMPLES, MAIL NOW!
AMERICAN AGILE CORPORATION, CLEVELAND, OHIO
Gentlemen: Without obligation send me samples of Agile Dark Green Electrodes. I have checked diameter wanted.
☐ 1/16" ☐ 5/32" ☐ 1/8" ☐ 5/32" ☐ 3/16" ☐ 1/4"
Name
Company
Address

and supplies, recently joined the sales force of the Acetylene Products Co., Indianapolis, Ind.

The Will-Weld Sales Co., marketing Will-Weld welders, has opened a sales office at 11125 S. Vincennes Ave., Chicago, Ill., under the direction of C. P. Nielsen.

Tube-Turns, Inc., Louisville, Ky., have moved from their old location at 425 Fifth St. to new and larger quarters at 224 E. Broadway.

Suburban Gas Sales, 5335 W. 23rd St., Cicero, Ill., have opened a new warehouse in Oak Park, Ill., to handle trade in that vicinity.

William P. Bowman, manager of the New York City branch of John A. Roebling's Sons Co., died on Jan. 22.

Notes From the Field

Hundreds of dollars in upkeep expenses are now being saved yearly in the Altoona shops of the Pennsylvania Railroad as a result of the use of welding in engine-tender repairs and gondola-freight-car construction, declares the general foreman of the tank shop of these works. Early in 1936, five 21,000 and three 25,000-gallon tenders were constructed in the Altoona shops with all seams and joints are welded. The upkeep on these tenders has been far below that on riveted tanks. All patching and repair work on these tenders is now being done with welding. Five hundred G-27 freight cars recently constructed had all center sills are welded to the bottoms, rivets being used only on the side panels. The cabs of the giant new electric locomotives constructed in the Altoona works are also are welded at all seams, approximately doubling the mileage obtainable before repairs are necessary.

One of the largest barge contracts to be awarded in many months was that recently placed by the Wheeling Steel Corp., Wheeling, W. Va., with the Dravo Corp., of Pittsburgh. The order calls for a fleet of 25 standard welded steel coal barges, each 175 ft. long, 36 ft. wide and 11 ft. deep. Approximately 2,700 tons of steel plates and shapes will be required for their construction. The new carriers, when completed, will be used in the local coal-carrying and steel-moving trade in the Pittsburgh harbor. These are the first welded barges ever to be purchased by the Wheeling Steel Corp. and marks a distinct step in the expansion of the company's fleet. Delivery will be made starting in the spring.

The city of Baltimore, Md., have taken bids for a large award of welded steel pipe, to be used in connection with the municipal water-supply system. The pipe will have ⅜-in. walls, butt-welded, 12 ft. in diameter, and in 40-ft. lengths. Each section will weigh approximately 16 tons. The purpose of the new equipment, for which a tunnel will be driven some 150 ft. under ground, is to replace the old water supply system now in use. According to the plans, the tunnel will be approximately four miles long and about half of it will be encased with this steel pipe. The other half will be concreted.

A master class in oxyacetylene pipe welding has been inaugurated at the Ohio Mechanics Institute, Cincinnati, O., and will meet on Saturday mornings for about three months. The class has been

OKOCORD

Extra Flexible

WELDING CABLE

● **Okocord Welding Cable is extremely flexible, which tends to prevent the welder's wrist from tiring. This flexibility is obtained by using a great many fine copper wires in the strand.**

These cables are protected from external abuse by a tough, tire tread type of 60% rubber jacket or sheath. This sheath is reinforced with embedded seine twine cords to withstand the tugging and yanking to which welding cables are subjected.

For long trouble-proof service, use Okocord.

THE OKONITE COMPANY

Founded 1878

and

HAZARD INSULATED WIRE WORKS DIVISION

THE OKONITE-CALLENDER CABLE COMPANY, INC.

EXECUTIVE OFFICE: PASSAIC, N. J.

New York, Philadelphia, Los Angeles, Boston, Pittsburgh, Seattle, Buffalo, Chicago, Washington, Dallas, Detroit, San Francisco, Atlanta

Factories: Passaic, N. J., Wilkes-Barre, Pa., Paterson, N. J.

organized through the joint cooperation of the Heating, Piping, and Air Conditioning Contractors Association, of Cincinnati and the executives of the Ohio Mechanics Institute. The class is limited to ten men. The general purpose of the class is to enable men who are already competent oxy-acetylene welders for ordinary pipe jobs to pass the very rigorous tests demanded by the A. S. A. Code for High-Pressure Piping.

The welding business in Detroit was hit by the automotive strikes. Welding shops showed an average drop of 40% in business during this strike, with some shops running as high as 80% drop, due to loss of General Motors orders. Sales of welding equipment and supplies took a similar drop, the average in this field running around 40%, according to O. L. Smith, general manager of the Weldit Acetylene Co. Resumption of business, now that the strike is settled, is expected to result in a big rush in this field, in order to catch up with back orders which have been placed for contingent delivery.

"Better than new" strength in cracked and broken auto frames as a result of welding is cited by J. F. Dolheimer, proprietor of the Dolheimer Auto Body Works, of 606 Twenty-Fifth St., Altoona, Pa., as one reason for a 50% increase in business. Mr. Dolheimer, who welds nothing but auto bodies, further stated that all bodies brought in for repairs, regardless of original construction, are welded, rather than riveted, thus saving auto owners much upkeep expense. As an example, he declared that he has bronze welded hundreds of auto spring hangers and has never had one complaint.

The Pennsylvania Railroad has just awarded a contract for five, all-welded steel barges, for service in the New York harbor, to the Dravo Corp., of Pittsburgh. Strange as it may seem, the Pennsylvania Railroad has been one of a number of carriers which in the past opposed in general the use of water-way transportation. These barges will be 80 ft. long, 30 ft. wide and 9 ft. deep. The material will be fabricated in the Neville Island yards of the Dravo organization and assembled at their Wilmington, Del., shipyards. Delivery is expected to be made early in the spring.

The State of Pennsylvania has effected a saving of aproximately 40% through the use of arc welding in the construction of a bridge over the Juniata River near Huntington, Pa., declares Frank A. Madden, of the Madden Boiler Works, of Hollidaysburg, Pa. The bridge, welded throughout, was constructed by this firm at a cost of $2,500 under a contract let by the state. Six

EASY-FLO

(U.S.Patent 1,899,701)

brazed joints contribute to good reputations

Because EASY-FLO makes consistently reliable joints high in strength, it is being used more and more in constructing well known products.

The G. E. Refrigerator is a typical example. In it from 33 to 37 joints are EASY-FLO brazed depending on the size of the unit.

EASY-FLO is selected for this as well as other important ferrous and non-ferrous work because it makes strong, permanent joints *economically*.

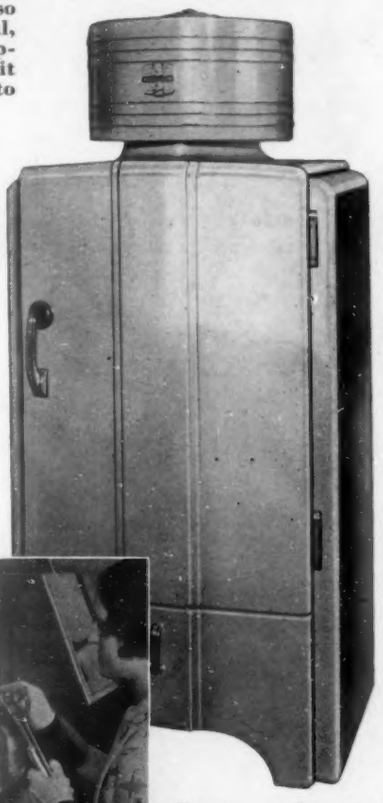
The working temperature of EASY-FLO — 1175° F. — makes it safe to use where higher heats may damage the physical qualities of metals. It joins dissimilar metals of thin or heavy section. It flows so freely and penetrates so rapidly on steel, stainless steel, Monel metal, Everdur, copper, brass, bronze and other copper-nickel and chrome-nickel alloys that it is being called the easiest brazing alloy to use where high strength is required.

Try EASY-FLO on your work — use our HANDY FLUX with it. You'll find this combination economical—a thin film of EASY-FLO makes a perfect joint—time is saved —less gases are needed. Savings are made that mount up fast in quantity production.

•

Send details of your brazing problems — we'll be glad to give our recommendations.

Write for Bulletin 102-W.



Copper tube and steel valve body being brazed with EASY-FLO to "Everdur" tube.

HANDY AND HARMAN

82 Fulton St., New York

weeks were required to complete the work. Mr. Madden declares that the strength of the new structure is much greater than would be that of a riveted job.

The Humble Oil & Refining Co., of Baytown, Texas, recently awarded a contract for 13 large, miscellaneous-sized oil tanks to the Bethlehem Steel Co., of Pittsburgh. The largest tanks are 42 ft. high and 78 ft. in diameter. There are three of this particular size and 10 smaller ones. The plates will be manufactured either at the Leetsdale, Pa., works of the Bethlehem organization or at Sparrows Point, Md. They will be fabricated on the job according to A. P. I. Code standards, and butt and lap welded.

A loss of several thousand dollars that would have been caused by temporary disruption of work was averted recently by the Municipal Paving & Construction Co., Chattanooga, Tenn., when a main side frame of a 24x36-in. rock crusher was welded in 12 hours on the spot where it had broken on a road under construction between Mountain City and Hampton, Tenn., in the east Tennessee mountains. The work was done by the Southern Welding Co., 415 W. Market St., Johnson City, Tenn., at a cost of $60.65.

A Safety Device Schedule was adopted by the Executive Board of the Compressed Gas Manufacturers' Association on Dec. 17. This schedule represents the minimum safety device requirements recommended by the Association for compressed-gas cylinders of a capacity not exceeding 1,000 lb. of water. It consists of four parts: Definitions, Safety Device Classifications, Design and Construction, and Applications. No recommended classification has yet been decided upon for acetylene cylinders.

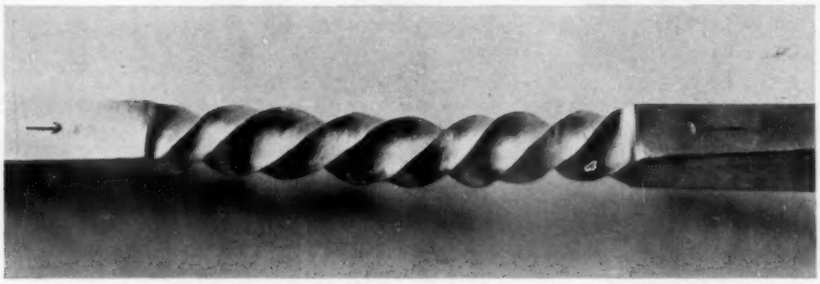
A contract for the construction of two standard coal barges of the combination riveted and welded type, has been awarded the American Bridge Co., of Pittsburgh, by the National Barge Co., which concern was organized recently for the purpose of chartering floating equipment to shippers. These barges will be 175 feet long, 26 ft. wide and 12 ft. deep and each will require approximately 300 tons of plates and shapes. Delivery is expected to be made within the next six weeks.

The Campbell Transportation Co., of Pittsburgh, Pa., is adding new equipment to its already large fleet. Announcement has just been made of a contract for 10 standard steel coal barges which has been awarded to the Bethlehem Steel Co., of Pittsburgh. These barges will require approximately 1,700 tons of steel plates and shapes, and will be used to move freight to southern points. They are now under construction in the Leetsdale yards of the Bethlehem company.

The Sixth International Congress for Steel Development will be held in New York City, June 28 to July 3, with the American Institute of Steel Construction acting as host. This is the first time the United States has been selected for the meeting place of one of these conferences, the purpose of which is to exchange information regarding improved methods of applying steel to construction and other uses. A number of European organizations will participate.

Ernst Bauer, E. E., realizing the shortage of welders in the Niagara Falls, N. Y., territory, recently started a welding school with himself as instructor. The school now has an enrollment of 25 consisting mostly of young men who work during the day or night in Niagara Falls industrial plants but wish to further themselves and secure jobs in the

This Torsion Test Proved the Difference



Penn Bronze* Strength is Demonstrated by this Drastic Twisting Test

The entire length of the piece illustrated is approximately 24 inches. The twisted, welded section is approximately eight inches. The steel is one inch square.

PENN BRONZE* was used for welding this section. The bead was built up a little larger than the square of the steel and then machined down to exactly one inch. The Torsion Test was then applied. This drastic treatment, as is shown above, failed to affect the weld. It did not break.

The reason why PENN BRONZE* gives greater strength, greater ductility, is because it has the exclusive feature—double de-oxidation. Double de-oxidation gives protection against the formation of gases and harmful oxides in bronze welding. It assures fine results.

(Trade Mark Registered)

Try PENN BRONZE* in your own welding operation. Ask your jobber for it. Or, if he does not handle it, send us his name and we will send you samples.

*U. S. Patent No. 2,022,439

Titan Metal Manufacturing Co.

Bellefonte, Pennsylvania

fast-growing trade of welding. The school bears the name of Niagara Frontier Welding School, and the address is 1119 Eleventh St., Niagara Falls.

Mayland H. Muse, proprietor of the Southern Welding Co., 415 W. Market St., Johnson City, Tenn., has developed a profitable sideline selling welded cylinder heads for all makes of automobiles. Mr. Muse takes in cracked cylinder heads, selling the welded heads for 50% of the cost of new ones. The work is done by employes during spare time, and many orders for the welded heads are received from points within a radius of 100 miles of Johnson City.

Adding to its already extensive welding program on Bahrein Island, in the Persian Gulf, the Standard Oil Co. of California is planning to treble the capacity of its refinery there. The company has erected a completely modern air-cooled town to house its welders and other employes. The heat on the island is one of the difficult conditions encountered, 118° being common, with much humidity.

J. C. Manternach was re-elected president and treasurer of the American Welding & Manufacturing Co., following the annual meeting of the stockholders on Jan. 25, at Warren, Ohio. Other officers include A. S. Manternach, vice-president and general manager, and E. W. Wilhelmy, secretary and assistant treasurer. Directors include J. C. Manternach, A. S. Manternach, E. W. Wilhelmy, G. C. Bolz and F. P. McBerty.

A contract for making 4,000 ft. of steel pipe and 600 elbows and tees, out of 20-gauge sheet, has been received by the Equipment Reclamation Works, 530 W. 79th St., Chicago, Ill. The pipe will be 3 and 4 in. in diameter, and all seams will be welded and ground smooth since the pipe is to be vitreous enameled. Welding will be done in the shop, using jigs, and all forming of the sheets will be done outside.

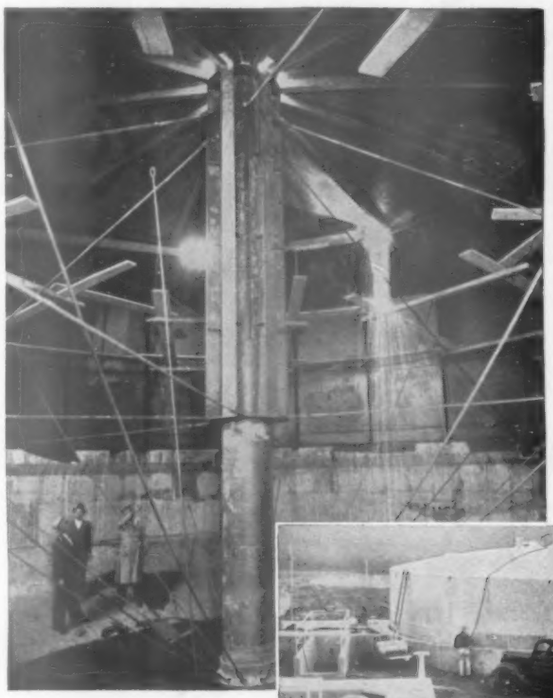
The huge electric dredge *Elizabeth Pfeil* of the Iron City Sand and Gravel Co., Pittsburgh, Pa., weighing approximately 900 tons, was pulled out on the Neville Island marine ways of the Dravo Corp. recently for repairs to the hull. Much activity is going on these days at the marine ways of the Dravo company, where river equipment is being reconditioned for spring trade.

Six welded steel sand-and-gravel barges will be built for the Warner Co., of Philadelphia, Pa., who awarded the contract for their construction to the Dravo Corp., of Pittsburgh. These carriers will be 130 ft. long, 34 ft. wide and 10 ft. deep and each will have a capacity of 1,000 tons. The material will be fabricated in the Neville Island shop of the Dravo organization and assembled in their Wilmington, Del., shipyards.

The Ingalls Iron Works, Birmingham, Ala., are reported to have received an order for six all-welded barges from the Warner Co., of Philadelphia. The barges and specifications are somewhat similar to those of an equal quantity recently awarded to the Dravo Corp., of Pittsburgh.

The new barge shops of the Dravo Corp. in Pittsburgh, Pa., which will be of all-welded construction, are being set up and it is expected that the building will be ready for occupancy about the first of March. This corporation further reports that the first steel welded barge out of an order of 25 for the Wheeling Steel Corp., Wheeling, W. Va., will be delivered early in May.

An oxyacetylene torch caused an explosion of an oil pipeline near Pryor, Okla. recently, costing six lives. An emergency crew were attempting to repair a leaking oil line when the torch set off the blast. Four of those killed were wives of workmen waiting in nearby cars to take their husbands home from



Welding Interior of Methane Tank Shown Below.

No Bolts or Rivets . . *Entirely Welded with* Ryerson No. 217 Electrodes

The Methane gas tank shown above was recently completed by the Moon Welding Company of Kokomo, Indiana. It was fabricated from 3/16" plate; is 50 ft. in diameter and 15 ft. high, with a capacity of 20,000 cubic feet. No bolts or rivets were used. Three quarters of a mile of welding was required with a total welding time of 311 hours.

Ryerson No. 217 electrodes (straight polarity) were used for both flat and vertical welds. These electrodes are especially suited to high speed single pass welding and for use where poor fit-up is encountered. Let us give you complete data on these and other Ryerson Electrodes. Write for bulletin.

Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Cleveland, Cincinnati, Detroit, Boston, Buffalo, Philadelphia, Jersey City

RYERSON

work. Details of the cause of the explosion were not given.

The Evans School of Welding, at 1562 E. Slauson Ave., Los Angeles, Calif., recently opened for business, featuring instruction and practice in arc welding. At present classes are held only in the evenings. Five arc welding units are in use. Instruction is under the direction of Mr. Evans, who is also associated with Charles Cooper & Co. as sales manager.

A steel highway bridge will be the subject of design in the ninth annual competition offered by the American Institute of Steel Construction to students of engineering and of architecture. Designs must be submitted not later than April 12, 1937. Circulars describing this competition can be obtained from the Institute, at 200 Madison Ave., New York, N. Y.

The U. S. Army Engineers of the Vicksburg, Miss., district will open bids Feb. 23 for the construction of a steel-hull derrick boat complete with derrick. Prices are being asked for both riveted and welded construction. Delivery is to be made within 160 days. The boat will be 100 ft. long, 44 ft. wide and 6 ft. deep.

The Wyoming Valley Welding School, Wilkes-Barre, Pa., has concluded 15 years of existence. The Lincoln method of instruction, with a period of 12 weeks of intensive training, is used in the school, according to William C. Haar, director. Mr. Haar also operates the Wyoming Valley Welding Co., and has been in the welding business for 22 years.

Wilbur M. Wilson, research professor, University of Illinois, well known in welding circles for his research work on welded structural joints, has received the James R. Croes Medal from the American Society of Civil Engineers for his paper "Laboratory Test of Multiple-Span Reinforced-Concrete Arch Bridges."

The Standard Oil Co. of Ohio, with general headquarters in Cleveland, is taking bids on a new 150,000-barrel all-welded oil barge for use in service on the Ohio River. This barge will be 150 ft. long, 26 ft. wide and 9 ft. deep and will be used for the transportation of gasoline.

The Cleveland School of Welding Alumni Association has started a blueprint reading class, to meet at least once a month, the first meeting being held Feb. 19. The class, which is open only to members of the Association, has hired an instructor through the Cleveland, O., Board of Education. Meetings will be held at 2261 East 14th St., Cleveland.

Two new 300-ft. all-welded freighters, the largest vessels ever built by welding on the Great Lakes, are to be constructed by the Great Lakes Engineering Works, Detroit, Mich., according to an announcement from The Lincoln Electric Co., Cleveland, Ohio.

After having used riveted construction for all their former outdoor substations, the Northern Indiana Power Co. is now constructing one of all-welded construction in Kokomo, Ind. The welding is being done by the Moon Welding & Supply Co. of Kokomo.

The U. S. Army Engineers in the Pittsburgh district are taking bids for repair to the steel hull of the United States dredge *Beaver* operated in the Pittsburgh harbor. This dredge is valued at $70,000.

The Bridgeport Machine Co., Wichita, Kan., have moved their welding department into larger quarters in order to accommodate their fast increasing business of unitizing and building of rig fronts.

Alfred E. Gibson, president of the American Welding Society, was recently elected president of The Wellman Engineering Co., Cleveland, O., which company he has served several years as vice-president.

Welding will form an important part in the early construction of a $30,000 addition to the plant of the Liquid Carbonic Pacific Corp., Ltd., at 2600 East 12th St., Los Angeles, Calif.

C. W. Cleland, of Baldwin Park, Calif., recently opened a job welding shop at 569 Foster Ave. Mr. Cleland is equipped with portable outfits for both shop and field work.

L. Massa, formerly associated with the Smith Welding Works, Monrovia, Calif., has opened a shop of his own in the 200-block on North San Pedro St., in Los Angeles.

The Northern Natural Gas Co., Omaha, Nebr., are building a new booster station at Otis, Kan. A great amount of welding will be required on this construction work.

At a cost of $13,500, Wm. Myers, welding shop owner of Fresno, Calif., has awarded a contract for repairs and additions to his shop at 1811 Santa Clara St.

● THE NEW DOCKSON

TURRET-TYPE

WELDING SHIELD

GIVES GREATER STRENGTH, ECONOMY AND SAFETY

Rivetless face-piece, formed from seamless heavy-gauge fibre sheet, eliminates all possibility of electric shock through the shield—permits easy, complete sterilization—and insures exceptionally long life with maximum economy.

Pat. Apd. For

UNIQUE LENS HOLDER PROVIDES ECONOMY AND CONVENIENCE

Made from special oil and heat resisting compound—reduces breakage and allows for instant changing of cover without removing colored glass.

NEW HEADGEAR GIVES EXTRA COMFORT

Instantly adjustable, really fits all heads—with new detachable head-pad that affords maximum comfort.

● IF YOUR JOBBER CANNOT SUPPLY YOU—WRITE FOR INFORMATION

C. H. DOCKSON CO., 2885 E. GRAND BLVD. DETROIT, MICHIGAN